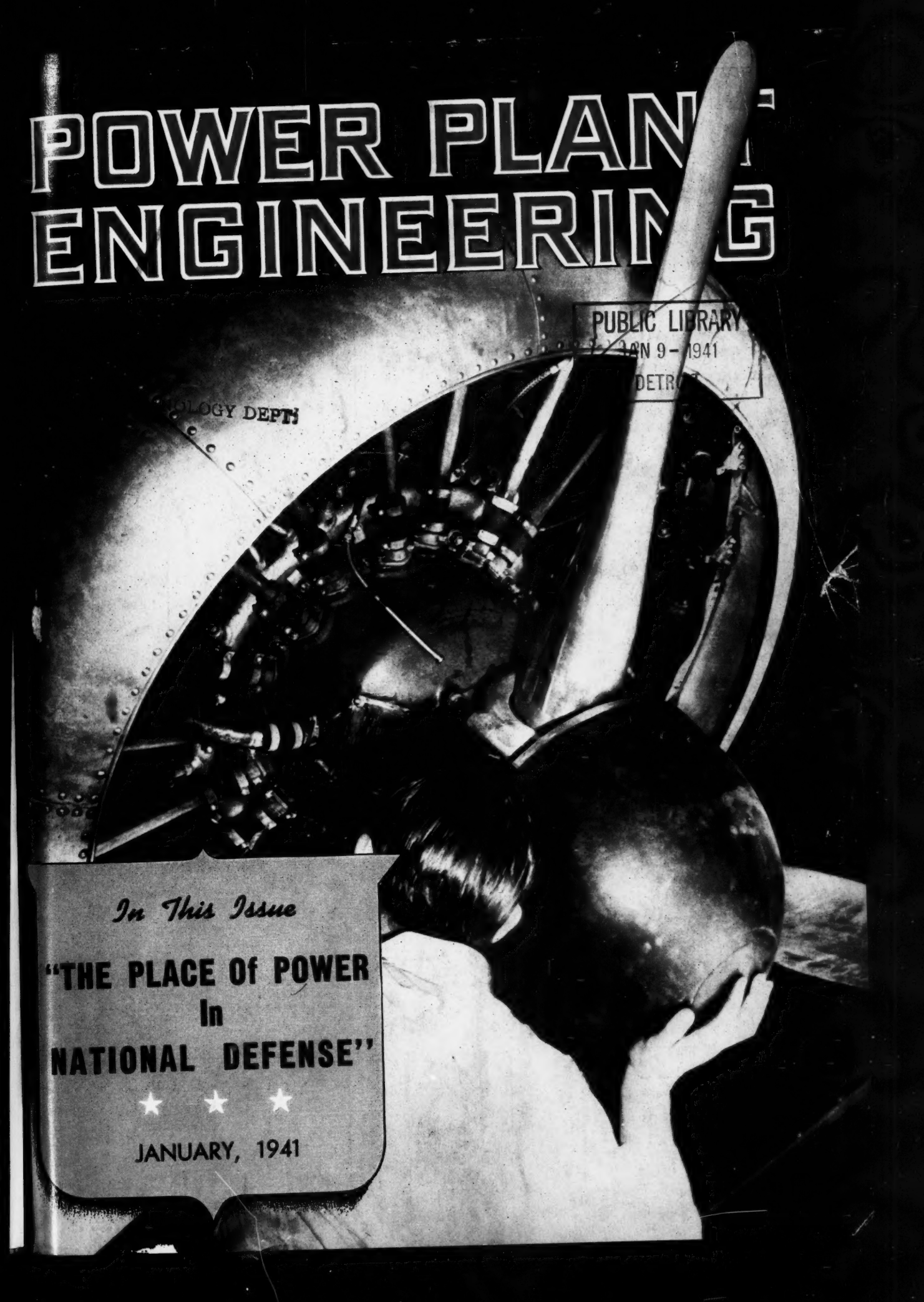
POWER PLANT ENGINEERING

PUBLIC LIBRARY
JAN 9 - 1941
DETR
OLOGY DEPT



In This Issue

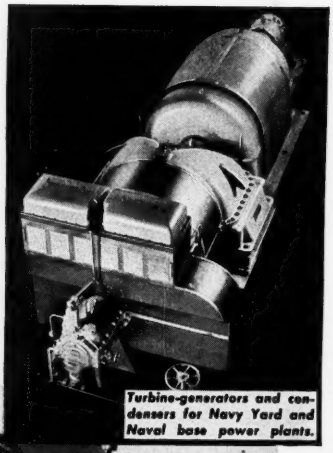
"THE PLACE Of POWER In NATIONAL DEFENSE"

★ ★ ★

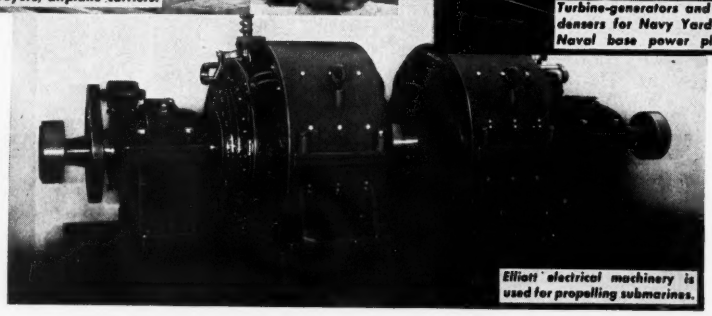
JANUARY, 1941

FROM KODIAK TO PENSACOLA

Marine type deaerating heaters for battleships, cruisers, destroyers, airplane carriers.



Turbine-generators and condensers for Navy Yard and Naval base power plants.



Elliott electrical machinery is used for propelling submarines.

The above illustrated equipment is only typical and does not show actual equipment furnished the Navy.

UNALASKA
SITKA
KODIAK I.
PUGET SOUND
MARE ISLAND
PEARL HARBOR
BOSTON
NEW LONDON
BROOKLYN
PHILADELPHIA
WASHINGTON
NORFOLK
PARRIS ISLAND
PENSACOLA

ELLIOTT

Q-1072

R v. 45 1941

POWER PLANT ENGINEERING

JANUARY, 1941
VOLUME 45, NO. 1

EDITORIAL STAFF

ARTHUR L. RICE
EDITORIAL DIRECTOR

RALPH E. TURNER
EDITOR

ANDREW W. KRAMER
ELECTRICAL EDITOR

RICHARD H. MORRIS
ENGINEERING EDITOR

PUBLISHED MONTHLY BY
TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.

KINGSLEY L. RICE
President

EDWIN C. PROUTY
Vice President

WALTER PAINTER
Vice President

ARTHUR L. RICE
Treasurer

CHARLES S. CLARKE
Secretary

ADVERTISING REPRESENTATIVES

CHICAGO: Charles S. Clarke
53 W. Jackson Blvd., Chicago, Ill.

NEW YORK: John A. Kershaw
Graybar Bldg., New York, N. Y.

PHILADELPHIA: H. G. Wilds
500 W. Clapier St., Philadelphia, Pa.

CLEVELAND: George E. Andrews
11733 Edgewater Dr., Lakewood, O.

Subscription price $2.00 a year in the United States and Possessions. Canada $2.75 a year. Other countries $3.50 a year. Single copy current issue 25c; back issue 40c. Copyrighted 1941 by Technical Publishing Company.

Cover: Technician installing de-icing equipment on an airplane engine propeller to prevent power loss. Wide World Photos.

Industry Speaks. By William L. Batt 45
The National Defense Program 46
Power and National Defense 49
Power and Industrial Preparedness 50
Men and Material For National Defense 54
What the Defense Program Means 57
Organization of the Defense Program 60
Military and Industrial Mobilization Plans 62
Peacetime Organization 63
Emergency Civilian Organization 65
Power Usage Increases Sharply 67
Direct Expansion Saves Cost on Ice Rink 68
Air Conditioning and Paint 68
The Practical Engineer and Electrician 69
Clearing the Right-of-way for the Bonneville Power Lines 86
Force, Weight, Mass and Acceleration. By Allen Keller 88
Defrosters Use 2500 Kw. 92
Load Conditions Determine Design. By Glenn M. Loomis 93
Rural Electrification in Illinois 96
Supercharging High Speed Diesels. By Robert P. Ramsey 97
2000 Lb. Topping Turbine at Montaup. By Elmer Smith 100
Mechanical Engineers In 61st Annual Meeting 102
New Equipment 108
Manufacturers' News 118
News From the Field 130
New Engineering Books 140
Power Plant Construction News 148

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

Suitable for ALL PRESSURES *without change of valve or seat*

Small size . . . Hardly larger than a pipe union . . . a fraction of the size of ordinary traps. ½-inch trap measures 2¼ inches; 2-inch trap, 4¾ inches long.

Light weight . . . Requires no support other than the pipe line, eliminating the bother and cost of complicated brackets and other structures. ½-inch trap weighs only 1⅛ lbs., 2-inch trap weighs 8½ lbs.

Low cost . . . It is frequently cheaper to install a new Yarway trap than to try to repair an old, worn, ordinary trap.

Easily installed . . . Straight line piping, together with small size and light weight of trap, simplifies the installation, makes a neater, better-looking job and leaves clear space around equipment.

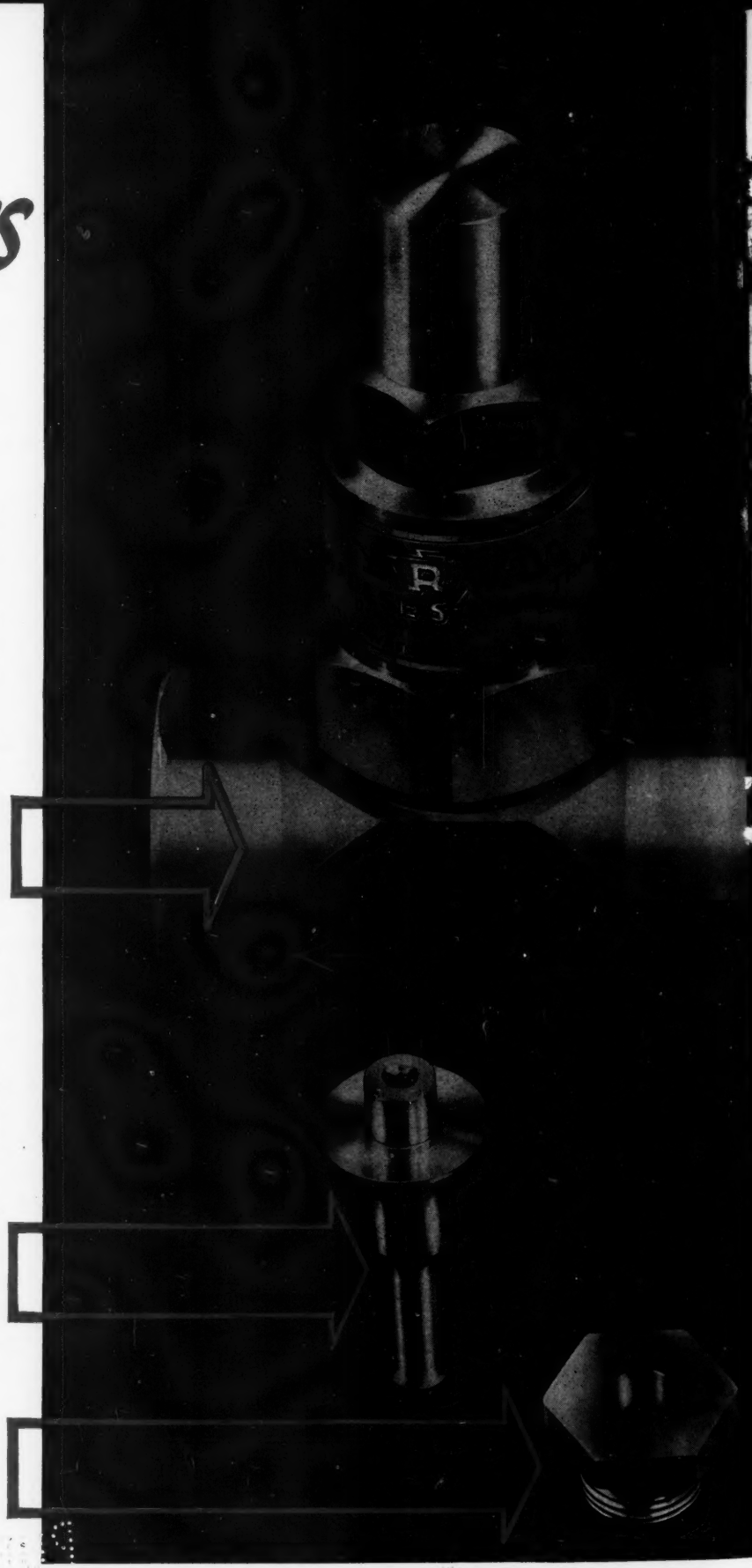
High efficiency . . . Faster heating and greater sustained heating efficiency, because this trap opens wide, discharging large amounts of air and condensate quickly at the start and continuously thereafter. Small size reduces radiation loss to a negligible minimum.

Less maintenance . . . Rugged bar-stock construction throughout. Only one moving part—a simple valve "F". Valve and seat of stainless steel, heat-treated for long life and severe service; body and bonnet of cold drawn steel, bright cadmium plated inside and out for permanent rust-free finish; control cylinder of stainless steel; cap of tobin bronze.

Standardized . . . Six sizes, ½" to 2", serve practically all trap requirements without change of internal parts. Standard construction (described above), for pressures up to 400 lbs., stainless steel trimmed for pressures up to 600 lbs. *Same valve seat for all pressures without change.*

Write for Catalog T-1735, or phone your Mill Supply House.

YARNALL-WARING COMPANY
114 Mermaid Ave. Philadelphia



ANOTHER YEAR OF WIDESPREAD POPULARITY

YARWAY IMPULSE STEAM TRAP

INDUSTRY SPEAKS

WILLIAM L. BATT on the PRESENT JOB AND POST WAR PROBLEM

HERE WE are on the very edge of a world in flames. . . . In recognition of this danger, we have set out upon the most gigantic program of armament ever undertaken by any country in history, a program that will roughly double an already great Navy, quintuple our Army and multiply a projected air program at least five times. And yet, I have a definite impression that the people of this country do not understand either size or the pressing urgency of this undertaking.

We are attempting to do more in 2 yr. than Germany did in six —Nazi Germany, whose entire national existence was geared to this one job of armament. We are attempting to do more than the British Empire has been able to do in 4 yr., some 15 mo. of it under war conditions. We must grasp the enormity of these facts and what they mean. We must somehow jar ourselves out of an attitude which, if not complacent, is in my opinion at least too easy-going. . .

Before we begin probing into the future we must first understand clearly the scope and something of the pattern of what we are trying to do right now.

We have passed the phase of letting contracts. We are, as Bill Knudson says, "tooling up". Unfortunately, that does not attract headlines. It would be more than unfortunate if the country were to draw the conclusion that we are standing still. We have a gigantic national job to do. It is, of necessity, barely getting started. Its urgency cannot be exaggerated. There will be many and painful delays. Only by the unswerving determination of a united people can it be done. So much for the present picture.

But what about the end result of this colossal world revolution and our preparation to defend ourselves against it? What about the future? We must face the perfectly plain, inescapable and inevitable fact that when this war is over, no matter who wins, the world will not resemble the world of 1939. . . .

If Britain is victorious it will be because of a new kind of leadership—a leadership of the working people—of the people who stand the brunt of the struggle—out of whose burning sacrifices has grown this epic soul. British Labor has been a hundred years trying by one means and another to reach this leadership—it now has it. . .

We have said that whether we like it or not, whether we send more help to Britain or none at all, whether we become an active participant or remain on the sidelines, this war has and is and will have a tremendous impact upon our national life. No matter who wins, the world will be fundamentally changed, and we shall have to deal with new and startlingly different sets of circumstances. The two facts that a world war is in progress and that we are engaged in a defense program that cannot help but have tremendous repercussions throughout our national economy, means that we must constantly keep an eye to the future effect of what is going on today—both in the immediate future and the long-range future. . .

Therefore it seems to me essential that we immediately create a small group of the ablest men in the country who would be charged with studying these long-range problems and working out solutions in advance. They ought to be set off in a corner by themselves, instructed to forget all about the immediate problems of procuring war material except as it affects the future national economy. They should set to work now on the preparation of an industrial demobilization plan. Nations have spent decades preparing plans for the conversion of a peace-time economy to a war-time economy. So far as I know, nobody has seriously undertaken the preparation of plans for the opposite process—converting a war-time economy back to a peace-time economy.

I sincerely believe that if we tackle this problem of post-war demobilization of industry and man-power with all the energy we shall be devoting to the opposite process, we can build an economy and a standard of living the like of which the world has never dreamed of. We can, in that process, lay the ground-work for an industrial system that will have as its only limits the limits of available manpower for production.

This system would be based on a price structure designed to reach a vast reservoir of potential consumers that have in the past only been able to afford the barest necessities of life. We would, then, not only be making plans for the demobilization of a war-time economy, but also planning for the mobilization of all our resources—human and material—for better living in a world at peace.

WILLIAM L. BATT is: Division Executive of Mining and Mineral Products under Industrial Materials Commissioner Edward R. Stettinius, Jr., of the Advisory Commission to the Council of National Defense; President of SKF Industries, Philadelphia, Pa.; and Past President of the American Society of Mechanical Engineers. As an engineer, an industrial executive and an active participant on the Advisory Commission, he is in an unusual position to gauge progress in, and present limitations of, our National Defense program. He is also one of the few to give serious consideration to the constructive assimilation of the tremendous industrial machine after the war is over. These remarks were made during an address at the Annual Dinner of the A.S.M.E. in New York on Dec. 4.

A Salvo at Night. Scene on the Deck of one of our Battleships an instant after a Salvo has been fired. International News Photo

The

EVENTS IN EUROPE and the Far East during the past year have produced widespread and unpredictable repercussions throughout America and the rest of the world. What, to many, began as a distasteful but remote event, now has become a matter of dominating importance in almost every aspect of our lives. After twenty years of uneasy peace, of small wars, invasions and "incidents" World War has again broken out in all its stupid fury and for the second time in a generation the United States faces a national emergency.

For the first nine months of the war most of us felt that the Maginot Line formed a sufficient barrier to keep the conflict, for us, something only of academic interest —a phoney war it was called. Then in May and June, with the sweep of the German column to the Somme and the Channel, we were suddenly awakened to the grim and fearful reality that the war was at our very door. We were confronted not only with a full scale spectacle of the kind of total war the feature writers had prophesied but with the inadequacy of our own position in the picture. The halting methods and divided councils of nations whose governments are based on the consent of the governed were shown to be inadequate in combating the swift, decisive aggressiveness of nations subject to the dictatorship of a single leader. Despite our tremendous natural and physical resources, we suddenly discovered that we were sadly deficient in the one important element that entered inevitably into every necessary operation—time. Time, the much discussed fourth dimension became a grim reality instead of an academic concept.

With this turn of events in the space of a few weeks, public opinion in this country swung sharply away from the peace at any price and appeasement doctrines to the desperate belief that our security could be guaranteed only by a strong national defense program.

As a consequence of this sudden realization of its deficiency in all branches of our military forces, the nation has turned its energies to adding to the strength of our defenses, with the hope that time still remains to accomplish the obvious minimum objectives. The nation's reserves of both the Army and Navy have been called up for active duty, conscription has been ordered and put in effect, the President has asked for and Congress has appropriated vast sums of money to be spent and new taxes have been levied. An air force of 50,000 planes is contemplated and contracts have been let to provide us, eventually, with a two ocean Navy capable of protecting the entire western hemisphere. A National Defense Advisory Committee has been appointed consisting of industrialists, Knudsen, Stettinius and Ralph Budd with Chester Davis, Leon Henderson, Sidney Hillman and Dean Harriet Elliott.

Numerous other committees have been created and other organization mechanisms set up to direct this vast effort. The Army and the Navy have had plans in effect for many years for just this sort of emergency—their plan for industrial mobilization—but up to the present time these have only been plans and the problem of carrying them out will require the active coöperation of government, industry, capital and labor in all its ramifications.

While there are many aspects to this vast undertaking the problem of manufacturing capacity is of

National Defense Program

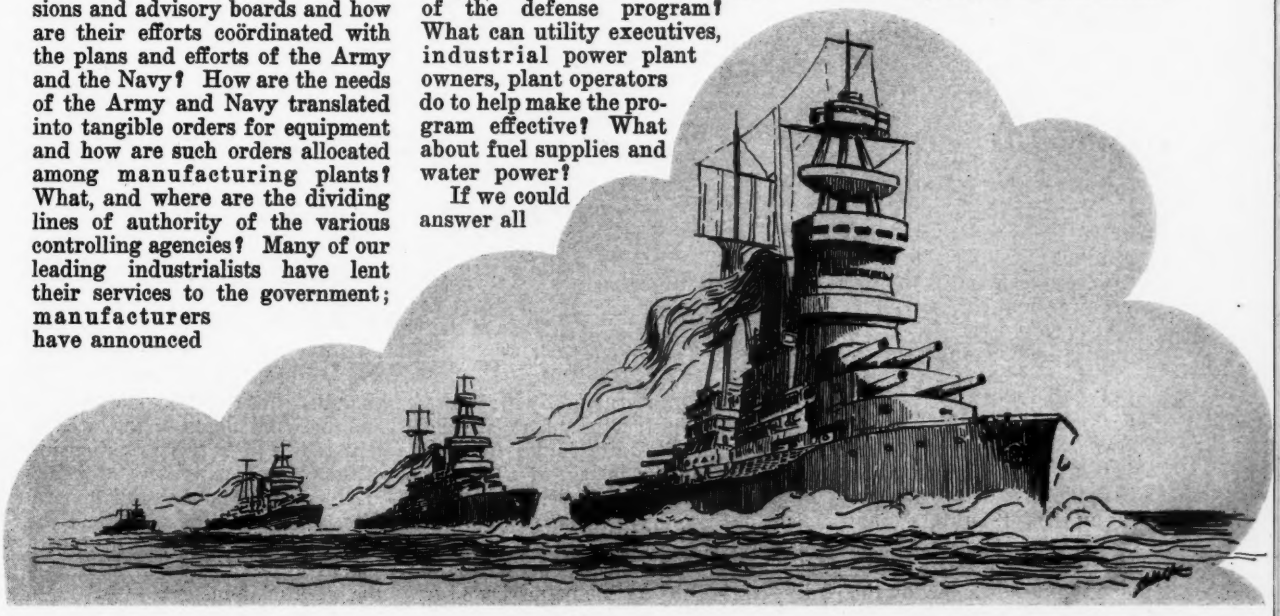
Its ugly head is up again and the slaughter is on. After twenty years of uneasy peace, World War has again broken out in all its stupid and senseless fury and for the second time in a generation the United States faces a national emergency. It is regrettable that people—people in the masses—come to knowledge only in the hardest way. For many years we have been looking for a new industry to lift us out of the depression. This industry has finally arrived in the form of a first class war. As a consequence we are engaged in a great national defense program. Since this defense program is of vital importance to the power industry an attempt has been made in the following pages not only to set forth the general aspects of this program but also to show how its mechanism is coördinated with that of the power industry in meeting the needs of the nation.

paramount importance—our deficiency in productive capacity in vital equipment form the so-called bottlenecks which may impede the movement of the program as a whole.

How is this great program being put into operation? What are the functions of the various commissions and advisory boards and how are their efforts coördinated with the plans and efforts of the Army and the Navy? How are the needs of the Army and Navy translated into tangible orders for equipment and how are such orders allocated among manufacturing plants? What, and where are the dividing lines of authority of the various controlling agencies? Many of our leading industrialists have lent their services to the government; manufacturers have announced their desire to coöperate; how do these men and their organizations dovetail into the picture as a whole?

What part does "power" play in the scheme of things? Is power a bottleneck, or if not now, is it likely to be? What are our actual power producing resources and how adequate are they to meet the needs of the defense program? What can utility executives, industrial power plant owners, plant operators do to help make the program effective? What about fuel supplies and water power?

If we could answer all these questions even partially, we ourselves would be in Washington giving orders, not talking about them, but we cannot. Nobody can answer all of them. Some can be answered quite concisely, others only in degree and many are only matters of conjecture. They are the questions in everybody's mind, however,



Next door to eternity. A view at the Picatinny Arsenal showing row upon row of 16 inch shells each costing $1000 and capable of spreading death and destruction at a point 15 miles away from the guns that fire them. International News Photo

and if we, collectively, knew the answers the nation would be better fitted for the tasks which lie ahead.

It is to be the task of presenting clear and concise information on these questions that some of our effort will be directed during the coming months. In the foregoing it has been implied that a mechanism exists capable of carrying out the defense program in minimum time; this may be wishful thinking. There are a number of agencies, we know, but how well they are coordinated we do not know.

Specifically our interest is in the way in which power enters the picture but the thing is so involved that one must have some understanding of the mechanism as a whole in order to evaluate the importance of power; we know that it enters vitally into every element of production and that if the flow of power is interrupted, production ceases. What the power industry wants to know, what it needs to know, is, how much power is likely to be needed, where and when.

At the present time and through this year, 1941, analysis shows that all demands for electric power, including those required for national defense can be met by the existing generating facilities although, as pointed out in a report by the Federal Power Commission "hot-spots" and "bottlenecks" may develop in certain areas.

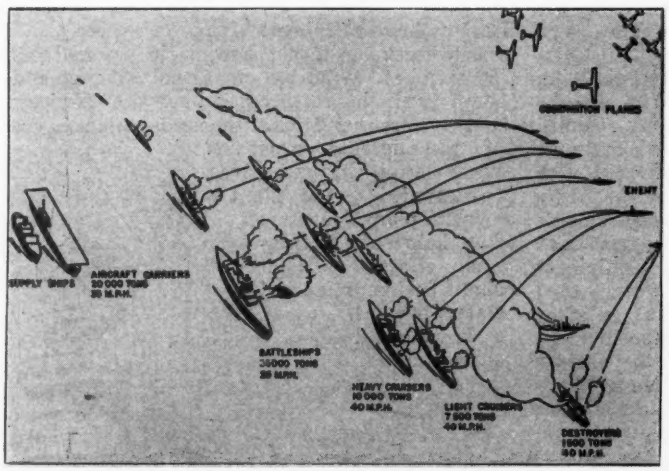
In most areas the full effect of the national defense loads will probably not be felt until next year, 1942, when, according to this same F. P. C. report, aggregate deficiencies in available generating capacity in certain areas will probably exceed 1,500,000 kw.

In view of the fact that from 18 months to two years is generally required to provide additional generating facilities and that from six months to a year is often required for the construction of transmission lines, it is quite imperative that long range analysis of the power requirements be made.

For many years, statistics regarding the generating capacity and the power production of the electric utility companies have been available. Similar data in regard to industrial power plant capacity or output has not been available, however, and estimates of industrial power plant capacity or output have been little more than guesses. Within the past few months the Federal Power Commission has set up machinery for the collection of data on industrial power plants and the release of this information from time to time should be of great help in forecasting defense needs in this respect.

The problem as a whole is very complex and the ramifications are so extensive that it is difficult if not impossible for any single individual or even a group of individuals to gain an understanding of the defense organization in all its details. Certain basic facts can be obtained, however, and in the months to come concerted and intelligent effort will be made to get these facts and present them clearly and, we hope, logically in the pages of POWER PLANT ENGINEERING.

A beginning is made in this issue. It is too early to present very much more than a general picture of the aims in view but these are of considerable interest and importance. Aside from general considerations of power and national defense, the articles that follow discuss the relationship of the various committees, how they are organized under the general direction of the President and the Congress and how they deal with the Army and Navy in allocating the work of industry.



The Fleet in Battle

POWER AND NATIONAL DEFENSE

WHILE THE industrial importance of power was appreciated long before 1916, fuel was the important power factor during the first World War and appointment of a Fuel Administrator, to stimulate production and eliminate waste, was one of the steps taken by the Council of National Defense soon after the war started.

At that time long distance power transmission was in its infancy with a large proportion of the power load carried by isolated plants. Furthermore, coal, which carried the bulk of the load and was already reaching new highs in production, was badly needed in chemical and metallurgical industries. The power problem was essentially a fuel problem, involving transportation and utilization of low quality coal for power purposes.

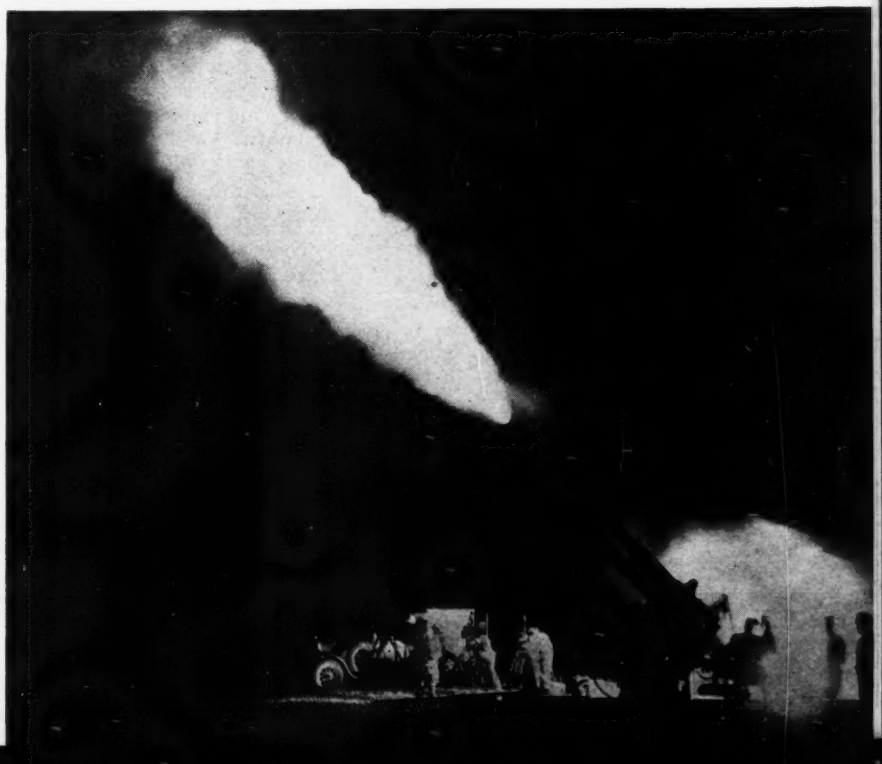
In the intervening 25 yr. the situation has changed. With mechanized methods coal production capacity has increased tremendously and production is still far below the peak capacity. Power plant efficiency has been doubled and low grade fuel is the standard ration of the modern plant. Again natural gas and oil are playing and increasingly important part as boiler and Diesel engine fuels. Many of the functions of the former Fuel Administrator are now taken over by regular government agencies established of recent years, namely: the Bituminous Coal Division and the Petroleum Conservation Divisions of the Department of the Interior; and the Federal Power Commission as administrator of the Natural Gas Act.

While fuel as an emergency problem was decreasing, power was steadily increasing. It was not until after the war that electric power, as contrasted to mechanical power, became of major national importance. The post war decade was the Golden Age of the utilities, the era of expansion, of long distance electric power transmission, of the super power plant and pulverized coal.

Industrially, its importance was irrefutably placed by the report of the President's Committee on Economic Conditions in 1929. It was impressed on the general public by the Technocrats during the depth of the depression and became a major political issue soon after. As an accessory of flood control, reclamation, public works, regional development and navigation, the TVA, Boulder Dam, Grand Coulee, Bonneville, Fort Peck, the Central Valley Project and a score of others were launched in rapid succession.

As a national defense issue, navigation has long been a pet of the War Department, and considering the vulnerability of railroads to bombing, probably destined to be of increasing rather than decreasing importance as an emergency military transportation channel.

The War Department, TVA, and Bureau of Reclamation play



One of our Anti-aircraft Guns in Action at Night. International News Photo

a part in this Federal development of power but the Federal Power Commission is the chief power agency. This Commission entered the picture under the Water Power Act of 1920 with jurisdiction of water power on navigable streams and over interstate movement of electric energy. In progressive steps the scope and authority of the Commission was extended until it now is quite complete. In conjunction with the Public Utility Holding Company Act, administered by the Securities and Exchange Commission, control of the utility industry is extended even to company organization and expansion of facilities.

Development of a co-ordinated Federal Power Policy, during the past 6 yr., has been largely up to the National Power Policy Committee, a related organization of the Interior Department. Its function is primarily collaboration, review and recommendation and its activities are closely related to the Federal Power Commission. The chairman of the F. P. C. is vice chairman of the N. P. P. C. and a member of the Subcommittee on Electric Power Problems of the Advisory Committee. Power is, of course, but one phase of the much broader national activities of the National Resources Planning Board which comes directly under the executive offices of the President.

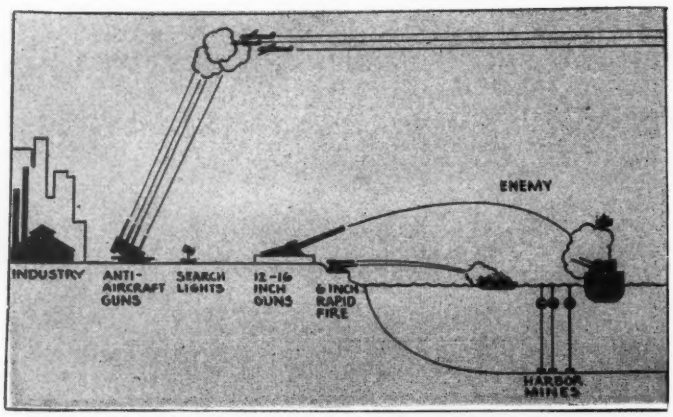
Beyond voluntary co-operation, authority to investigate and act on power requirements for National Defense rests largely with the Federal Power Commission. These are quite broad and cover Federal operation of any licensed hydroelectric project as well as emergency facilities to generate, interchange or transmit electric power to serve the public interest.

In 1935 the first National Power Survey of private and municipal electric utilities was completed and the conclusion drawn that normal industrial production would result in utility power shortages in all but eleven states. In co-operation with the utilities and manufacturers acting as a subcommittee on Standardization of the National Defense Power Unit, a standard for turbines of 10,000 kw. and over was drawn to speed up power station construction schedules.

Industrial power surveys are more difficult. Data collected for a number of years by the Census of Manufacturers was not entirely adequate. A survey started by the F. P. C. as an extension to the utility survey was completed only for certain regions and industries due to inadequate funds. A more complete survey covering every manufacturing plant in the country of more than 100 hp. connected load was made in 1940.

This covers the energy requirements and peak demands of purchased and generated power, information vital to the National Defense program to prevent an undue and unexpected load to be thrown on utility systems in certain areas.

Of recent years the industrial surveys of the War Department have been paralleled by similar investigations of the National Defense Power Unit of the F. P. C. of both public and private power. While not as comprehensive as the recent survey mentioned above, this did give data for spot placing of strategic industries and districts. Power has a place in the Advisory Commission of National Defense, under the Commissioner of Industrial Products as covered in a later article.



U. S. Coast Guard Artillery

Power

NATIONAL defense means the protection of the nation's people, its lands, its natural resources, its buildings, industries, transportation facilities, communication and power lines, and above all its right of self government, against the aggressions of outside nations. In any program of national defense, the generation and use of power must, in this day of mechanization, take an ever increasing part.

At every step from the mining of metals to the finished instrument of defense or war, power is used not only to relieve the physical burden on men but to speed up production through the use of power driven tools. In the production of many chemicals used in warfare, electric power is indispensable where electrolytic methods are employed. Food processing from the grains of the fields, the fruits of the orchards, the vegetables from the ground and the meats of animals, fowls and fishes, has come to depend in large measure on power and heat supplied by power plants. Clothing is no longer the home-spun, home-sewn article it once was but almost universally the product of factories that depend in extremely large measure upon the services of power plants. Leather and substitutes made into articles of apparel require power to complete their manufacture. Building materials made from products of the forests, pits and quarries are dependent in large measure on power for their processing. In fact, every material used today in quantities by industry and in domestic life comes to its destined use through some service of power.

Protect Power Sources

At every turn, therefore, it behooves the nation to provide protection for its sources of power, the means for generating power, the provisions for transmitting electric energy and the machinery for utilizing this power in the manufacture of essentials for human life and warfare against aggressor nations.

To the power plant management and operators, defense means strict

And Industrial Preparedness

attention to the condition of every detail of equipment, together with a careful determination of unquestioned loyalty of all workmen. It means arranging for substitute sources of fuel to be used in emergencies and providing proper equipment for using these fuels economically. It means installation of power generating equipment sufficient for all likely increase in load with emergency units to spare. It means providing guards at approaches to the plant and fences and lights and alarms to prevent prowlers and other undesirables from gaining entrance to the premises. It means providing facilities for quickly connecting the power plant with outside sources of power, in some cases even two separate power plants are advisable. It means the financing of plant improvements, extensions and protective measures.

Equipment Condition

The first line of defense in the power plant is the condition of the machinery, control equipment, piping, electric wiring and important elements of the building structure. Under the strain of an over-loaded condition, particularly over extended periods of time, weak points in the equipment are sure to make themselves known, first, perhaps, by trivial annoyances, such as slight leaks at packing joints, hot bearings, furnace clinkers, unusual vibration of high speed machinery, sluggish action of control equipment, or any one of a thousand other symptoms of diseases to which machinery is heir. The next stage, if conditions are not corrected, is more serious and forced shutdowns become imminent or necessary at times when the equipment is needed most. The third stage is the breakdown when the equipment actually gives way during operation.

Of course the proper thing to do is to catch undesirable conditions in their incipiency and correct them before they have an opportunity to reach the second or third stage. This, however, is not always an easy thing to do particularly when the equipment is in constant use. In times of stress, therefore, extra precautions are necessary and some plants have found that the condition can best be met by increasing the number of trained operators who are instructed to keep extremely close watch of equipment under their care and report immediately any undesirable condition. Investigation as to the cause is the next immediate step with full correction following without unnecessary delay.

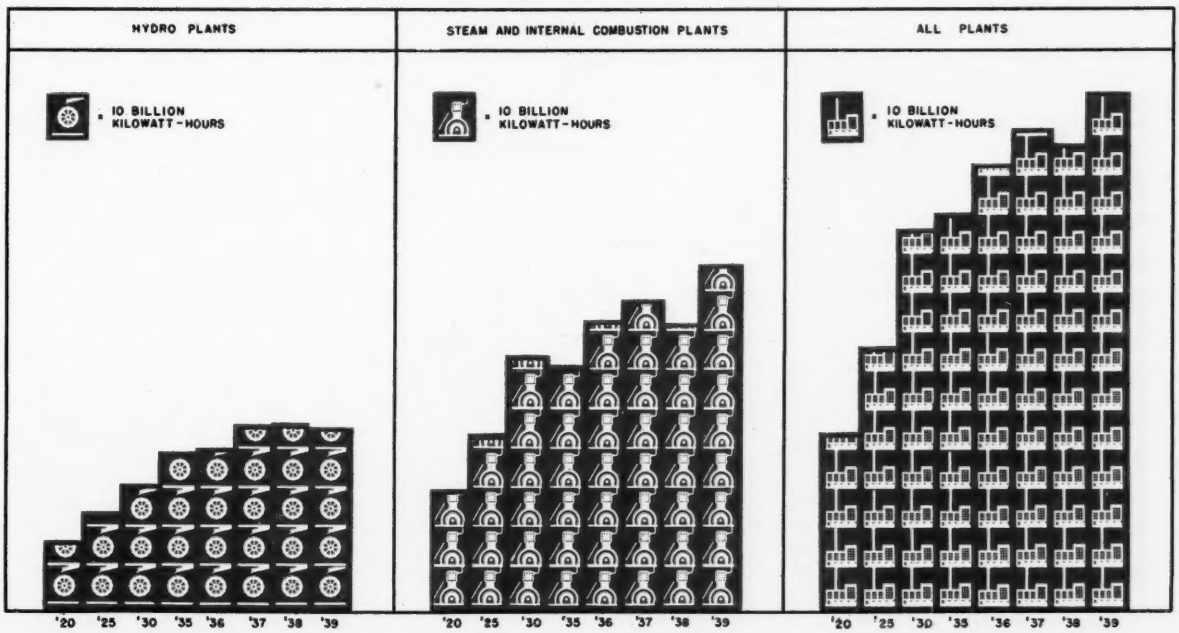
In many instances worn or weakened parts do not show up in the operation of the equipment until a break occurs. It is for this reason that provision for more frequent inspection is desirable during times when equipment is operated long periods at full capacity. To be effective, such inspections must be thorough and complete in every detail, amounting, in the case of many units, to the extent of completely dissembling and putting the parts together again with defective parts replaced by new.

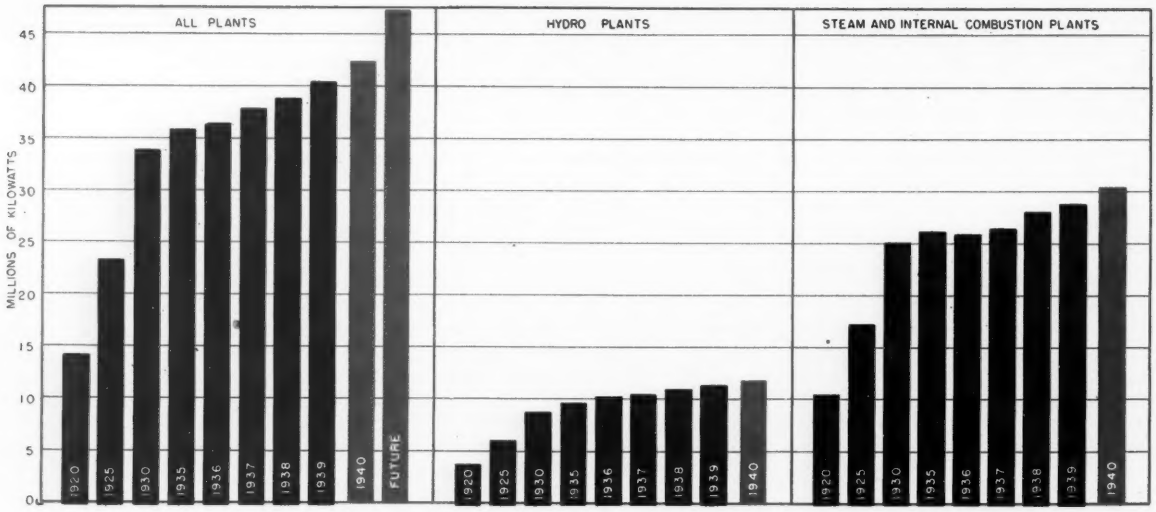
Daily operating reports are, of course, essential but for the protection of the plant against the acts of saboteurs detailed reports of every suspicious condition, no matter how apparently trivial it may seem, would be helpful not only in averting accidents but in detecting culprits if malicious acts are committed.

Fuels for Defense

Products of factories the country over will, according to Army

Production of Electrical Energy in the United States.





Installed Capacity of Electric Generating Plants in Service

estimates, be increased about 10 per cent. This of course does not mean that each factory or industry will have a 10 per cent increase in output. A few specifically war industries will experience a boom period, others will trail on down to the point where concerns manufacturing products that are considered nonessential will find these lines even lagging behind the production of today. The aggregate result, however, is estimated as stated above at about a 10 per cent increase.

It is evident that, since nearly every phase of our living activities requires power, national resources will be called upon more heavily than in normal times. Under present custom, water power is used to the full extent of its availability so that any additional power required in the present emergency must come from fuel. There are of course some government hydroelectric projects still under construction which in time will be available for the production of such war materials as aluminum and nitrates but, for present additional needs, industries must depend upon fuel generated power.

In arranging for plant improvements, additions, extensions or entirely new power plants, it will be wise to make provision for the use of fuel from several sources and different methods of delivery. It may be granted that a particular kind of coal gives the highest economy in the plant you are operating, that coal may be specified by the War Department for the making of metallurgical coke and power plants may be required to use something else. During World War I transportation was such a limiting factor that power plants were required to use the fuel available in their zone regardless of its fitness for the available equipment. Since that time, manufacturers have developed burning equipment that has considerable flexibility in its adaptation to fuels. Pulverized coal burners permit the use of a wide variety of coals, some designs even provide for the use of oil and gas. Traveling grate stokers have been improved to permit the use of a wider variety of solid fuels. The same may be said of the underfeed type, and spreader types have undergone almost revolutionary changes in design which have brought them into popularity in the smaller power plants.

Oil and gas are in many ways ideal fuels but more than likely these fuels will be greatly limited as steam generating fuels since they can be used directly in internal combustion engines, and oil is so universally used in mobile war equipment. Coke breeze and petroleum carbon will probably be found more plentiful as byproduct fuels as defense measures proceed. The possibilities of using these fuels are, therefore, well worth considering.

Modernization and Expansion

Above all else, national defense requires dependability of power plants serving industries. When electric switches are thrown in, industry wants power. Where it comes from or what it costs seems to be of little moment during war times. To supply this power a plant must have its equipment in operating condition and it must have sufficient capacity to carry the load demanded of it. A study of the plant operating record over a two or three year period should point definitely to features of the plant that are causing troubles that need correction before greater loads are placed upon the plant.

Industrial power plants, as a whole, are far from modern in their equipment. Old plants serving essential industries will have increased loads and longer service hours placed upon them. These are conditions that give little opportunity for the operating force to make the necessary inspection and repairs. So in the interest of national defense, old plants that are scheduled to serve essential industries should be modernized, with reliability given first consideration.

In some plants this may require only the inspection, thorough overhaul and repair of main and auxiliary equipment. In others it may require replacements of worn out or outmoded units, still others will find it possible to increase capacity, reliability and economy by the addition of auxiliary equipment such as air preheaters, economizers, forced and induced draft equipment, furnaces with higher heat release, water walls. Some of the larger plants will install superposed generating units and high pressure boilers. Others will find that proper water treatment will increase reliability and cut down the frequency of boiler cleaning. Slight changes in boiler tube ar-

rangement may be the solution to slag troubles with boilers run at high rating.

Electric generating units cannot be run above their design capacity for extended periods due to over heating. Where cooling provisions have not been made part of the design features, however, it is possible in some instances to increase their capacity several per cent by installing cooling equipment. In many factories power factor is so low that the generators cannot pull their rated kilowatt capacity because of the wattless current. Where this condition exists corrective measures are offered by synchronous motors or capacitors.

Then again wiring losses may account for as much as 10 or 15 per cent of the factory load. This loss which varies as the square of the current is readily detected by the voltage drop on the line and can often be reduced by careful location of distributing transformers or in some cases by rewiring departments or entire systems. Another and very effective method for reducing the generator load and at the same time improving factory lighting is by the use of fluorescent lamps. They not only give more lumens per watt but can be designed to emit light that is best suited in color for the work being done in the space lighted.

Then, unquestionably, as the national defense program continues, factories specializing in essential products will find need for entirely new buildings and power generating facilities. In such cases management should avoid the temptation to build cheaply for temporary service as was done in many cases during World War I. There is scarcely a product required for national defense, except actual fighting equipment, that is not used extensively in civil life. So it behooves management faced with a need for factory buildings and power generating equipment to build for permanence and economy, and to provide the plant with the most modern highly efficient standard equipment.

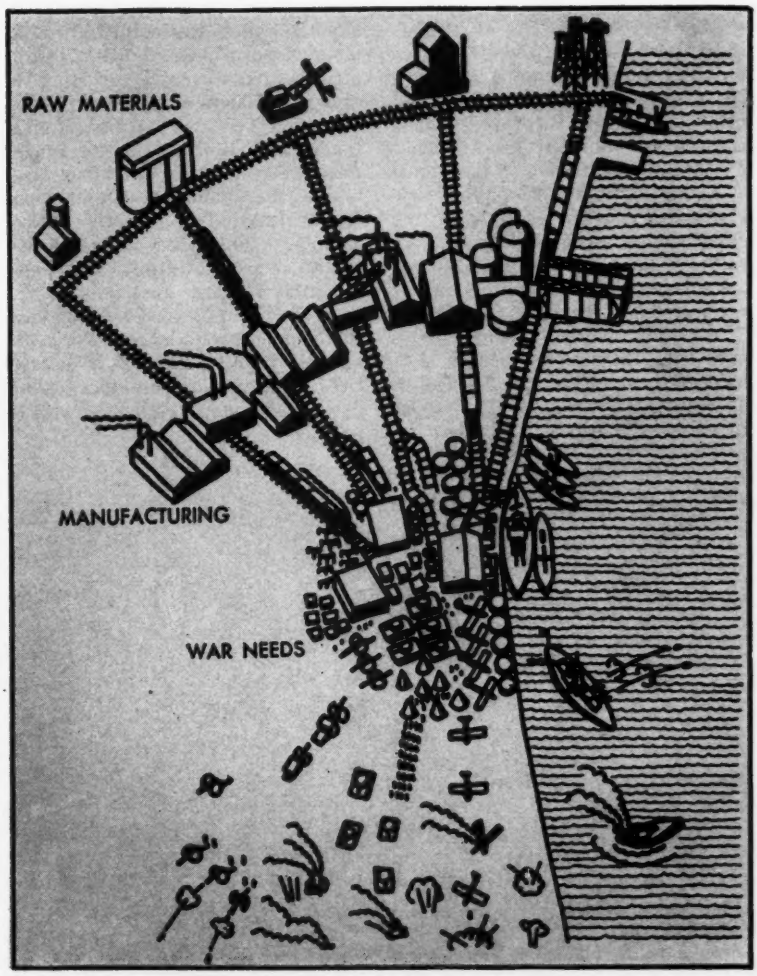
Standby Power

Reliability is the all important requirement of national defense. It is, therefore, wise to make provision for supplying power from two or more sources other than that regularly depended upon to supply the factory. It is impossible to predict just where failure may occur, whether it is accidental or intentional, but with several power sources the possibility of complete power failure is reduced by just that much. This standby power should be as nearly completely independent as possible. Power plants built with boiler and generator as a unit would seem to be a practical arrangement so that each unit could be isolated or interconnected with others when need be. Such a standby provision would require considerable additional power generating capacity if the plant depended solely upon its own equipment.

In most cases industrial plants will depend upon public utility service for emergency power. In this case independent service lines could be provided entering the premises at separated points and preferably serving the plant through independent substations and switchboards.

Storage battery installations have been found to serve institutional plants very nicely during emergencies and offer a solution for a similar purpose in industrial plants though of course they cannot be depended upon for continuous service without current charging facilities. Again some plants may find their solution to the emergency power problem in the installation of Diesel engine generators or gas engine units.

Failure of power due to the natural wear and tear on the equipment is a problem with which engineers are familiar and are ordinarily prepared to meet. Failure due to sabotage is quite another problem and no general directions, other than frequent inspection and a careful watching of individuals' activities, can be given to the man interested in national defense.



Providing War Supplies to the Nation. Drawn by Pictorial Statistics, Inc., for "If War Comes, Mobilizing Men and Machines" by Percy W. Bidwell and published by the Public Affairs Committee, Inc.

MEN AND MATERIAL FOR NATIONAL DEFENSE

MODERN warfare is waged with machines operated by trained men. No longer is the army at the front the major bulwark of defense nor are the men who compose this army the only ones subject to enemy fire. In nations at war no individual person, home, office building, factory, power plant, utility works of any kind, school, hospital or church is spared attack from a man-operated instrument of death and destruction in the hands of enemy fighters. National defense, therefore, has for its purpose the coördinating of all the country's resources and energies into the one common cause of preventing enemy forces from entering our borders.

In this cause fighting forces must be mobilized, armed with modern equipment and trained to operate that war machinery so as to achieve results. Each fighting man must be an expert with the equipment he must handle. His life as well as that of many others may depend upon a single successful performance.

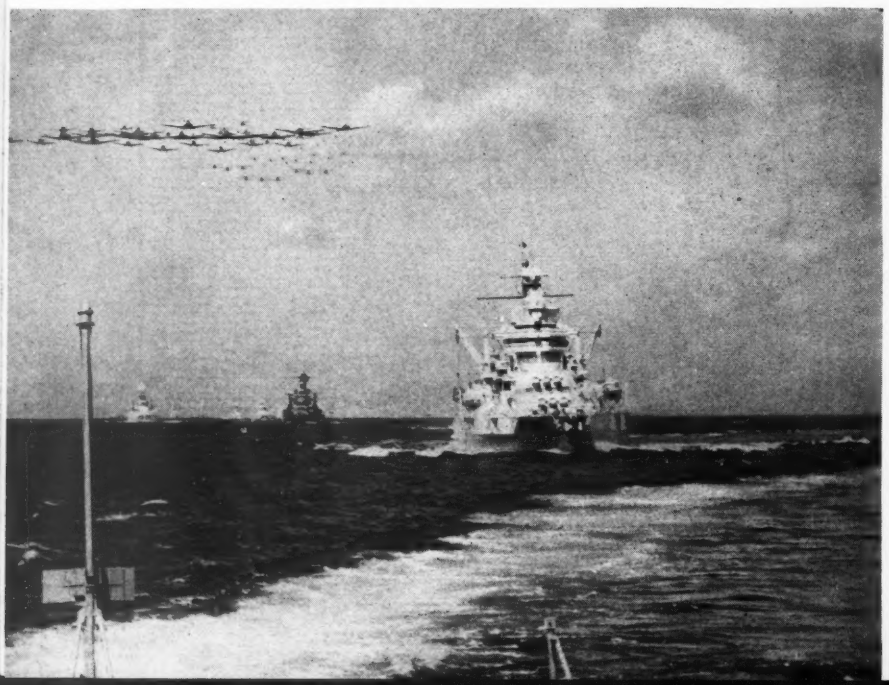
Back of these fighting forces must be a mobilization of industrial labor to supply the fighting equipment. Guns of every description require precision accuracy in their manufacture. Airplanes, tanks, trucks and other automotive equipment are the products of specially trained mechanics. Industrial chemists are needed to man the chemical plants supplying war materials to the men in training and those in actual warfare. Instruments will be needed in quantities. Cartridges, shells, hand grenades must be made and filled with explosives in quantities. Thus industrial labor of all description has a distinct service to perform.

Business, that indescribable, all-inclusive activity of a major portion of the population of the nation must be mobilized to expedite the movement of materials from their original sources, through manufacture or processing into essential supplies and equipment, to the points of use, be that in factories, training quarters or at the fighting front.

Agriculture, too, must be mobilized. Its fields must be used to supply the grains used for foods for men and animals, the fibers for clothing and building materials, the domestic animals yielding meats, fats and hides. When mobilized, agriculture will be controlled by governing authorities who will specify crops to be raised, method of care, time and place of marketing and many other details now matters of individual judgment and action.

Financing national defense or war will not be left to individual desires or private institutions but all finance will be mobilized to carry out the national program. Prices and profits will be stabilized and rigidly controlled, and foreign trade will be under the strict supervision of the government.

In October some 16,500,000 men between 21 and 35 yr. of age registered for selective compulsory military training and service. It may be expected that the regular army of 300,000 to 400,000 men will be trained to perfection and equipped in the most modern and complete manner. In addition there will be the National Guard and auxiliary forces whose duty at the outset of mobilization

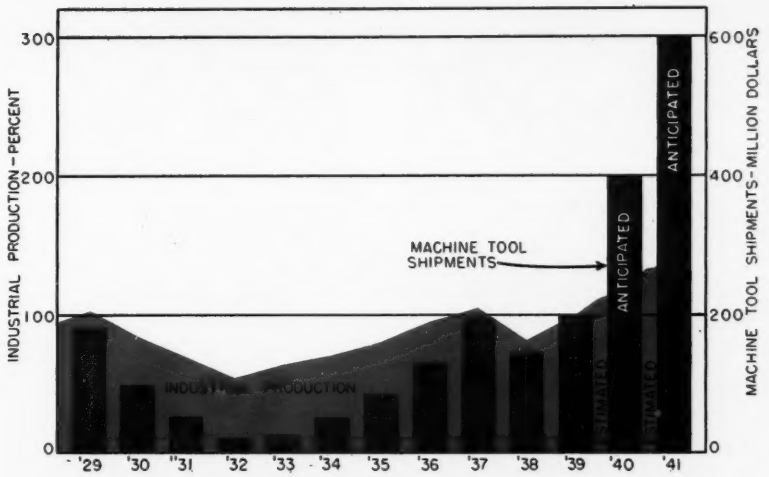


The Navy Is Our Traditional First Line of Defense. Navy Dept. Photo

would be to handle the military services not connected with active combat. The training of the new forces that have come into being as a result of the selective service draft will be carried out through the Reserve and National Guard. This plan leaves the expert regular army of 300,000 to 400,000 men free for combat at any time needed.

At present the National Defense Advisory Commission has for its goal the providing of equipment for a modern army of 2,000,000 men and for a two-ocean navy. First steps in mobilizing industry to supply the needs of the defense program have largely been taken. For a number of years surveys of industrial establishments have been in progress to determine what factories have facilities for making war materials and their present capacities. Designs of various equipment have been made and their specifications written and approved. The letting of contracts comes next and this work has proceeded with extreme rapidity since the national defense appropriation was made by Congress last summer with the major portion of the needs for the initial portion of the program contracted for. It will, however, be a number of months before this equipment is completed and delivered.

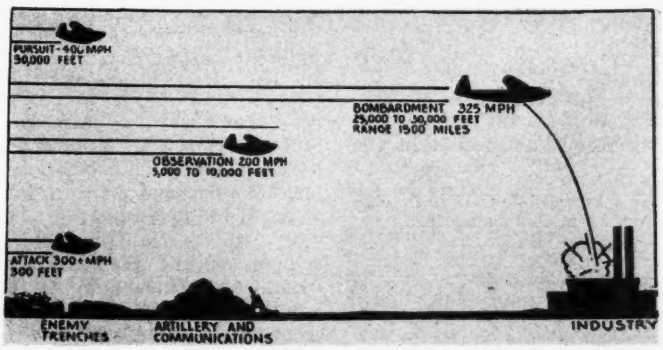
Notwithstanding the rapidity of this preliminary preparation for defense, much of the equipment used by the Army and Navy, such as guns, tanks, airplanes and rifles,



Machine Tool Shipments and Industrial Production Index. Federal Reserve Bank

work of preparing for mass production is going on, the Defense Commission has the job of keeping things running smoothly, of speeding up here, slowing down a little there, looking and planning ahead, and meeting problems before they arise.

Up to the first of January1941 little more than the work of preparing for quantity production of materials, supplies and the lighter equipment has been accomplished in the program but by the spring of 1941 production will be rising rapidly. The preparation for the building of mobile equipment for land forces, airplanes for defense or war purposes, and navy vessels in anything like quantity production is going to take many more months,



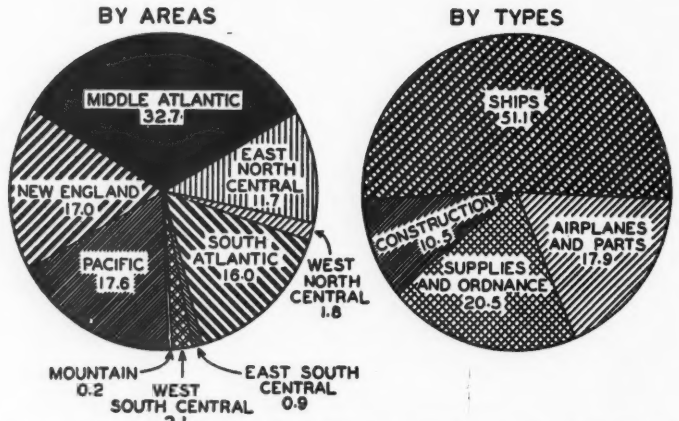
The Air Force in Action

are not regular peace-time products of many of the manufacturers who are preparing to supply them at this time, so rather hasty preparations are being made to tool-up factories for these new products. In this machine age, mass production of a new product is a major step and requires time to perfect, so full production cannot be expected for some months to come. While this although schedules calling for delivery of 25,000 trucks to the armed services before the end of 1940 have been worked out with manufacturers.

Army tanks are not the simple piece of equipment the layman is inclined to think they are. One of these units is in fact a miniature mobile fortress carrying eight to ten tons of armor plate that will stop anything up to a good-sized cannon shell; its driving unit is an engine of some 200 hp. capable of carrying the tank at a speed of 50 mi. per hr. and over almost any kind of ground; traveling on a set of caterpillar tracks, it can negotiate hills, muddy roads and even swampy ground; it carries a half dozen machine guns that can shoot two thousand shots a minute; it is equipped with a radio set to keep in touch with the commanding officer; and of course it must carry a supply of fuel and a full complement of driving instruments.

Production of these units starts with the design. It takes about 2500 individual drawings to build a light tank, the larger ones take more. Then comes the problem of designing and building the machines and tools to make the various parts of the units. Many of these manufacturing machines and tools had to be built especially for the making of tanks as these are not peace-time products and equipment had not, prior to the start of the defense program, been manufactured in sufficient quantities to supply the needs of those building tanks today. All this means new or additional plant facilities which are rapidly being provided but the full program of tank production is still several months away.

In addition to tanks, mobile land forces use motorcycles, scout cars, contact cars and troop transport cars. As a rule such units are peace-time products that have been built in mass production for a number of years. The dressing up they require for military service is not great so present manufacturing facilities will need little more than speeding up to meet requirements.



Percentage Distribution of National Defense Contracts, June 13—October 31, 1940

Supplying the country's defense needs for aircraft is one of the biggest problems of the program. To accomplish the aims of the Defense Commission, the industry has had to start with the facilities of a very limited number of factories and assembly plants. In September of 1939 when hostilities started in Europe the American airplane, engine and propeller factory working area was little more than 9,000,000 sq. ft., it is now nearly 17,000,000 sq. ft. and with plans now under way will reach 33,000,000 sq. ft. by 1942.

Three factors enter into the problem of speeding up airplane production—standardization of design, a certain amount of retooling, and plant expansion. The first step has been taken with the result that production in a single factory equipped to make 150 to 200 airplanes a year can, by tooling up, be increased to 2000 a year, an amount which enables the manufacturer to make the investment for greater production profitable. Throughout the country, the total production of airplanes is approaching the 2000 a month rate and by the end of 1941 it is anticipated that the rate will be increased to 3000 a month.

To build a two-ocean navy means practically doubling the present fleet and this program will take several years to complete. Much has been learned during the past decade in shipbuilding which has seen the comissioning of 130 new naval vessels and the approaching completion of 66 others, all of which serve as prototypes for the other ships of the same class which are following.

During the first few weeks that the National Defense Advisory Commission was operating, contracts were cleared for almost 100 new hulls. The time it takes to build a ship has been materially reduced. Several months have been cut off the time required to build cruisers 2 yr. ago. The same is true in regard to building submarines.

All this activity of industry to put itself at the service of the government in a program to provide adequate national defense calls for increased production of nearly every manufactured article, and there is every indication that the power generating facilities of the country will be compelled to expand their present capacities.

Distribution of National Defense Contracts

Divisional Distribution of National Defense Contracts Awarded June 13 to October 31.[1] Compiled from Government Reports by the National Industrial Conference Board.

Thousands of Dollars.

Nation and Division	Total	Army and Navy Combined			
		Construction	Ships[2]	Airplanes and Parts	Supplies and Ordnance
United States and Possessions	8,352,282	874,112	4,270,761	1,499,076	1,708,333
New England	1,398,717	74,196	1,014,700	132,907	176,914
Middle Atlantic	2,675,750	99,081	1,629,074	292,951	654,644
East North Central	963,964	148,712	33,162	88,590	693,500
West North Central	146,815	20,206	.....	97,870	28,739
South Atlantic	1,311,743	168,862	814,585	229,300	98,996
East South Central	76,580	27,363	29,286	.....	19,931
West South Central	172,869	62,526	94,100	1,860	14,383
Mountain	12,821	7,297	.....	.....	5,524
Pacific	1,446,782	119,684	655,854	655,598	15,646
U. S. Possessions	146,241	146,185[2]	.....	.....	56

[1]Construction contracts are alloted to the division in which construction is undertaken. All other contracts placed with producers are allocated as closely as possible to the division in which actual production will take place.

[2]Includes a small amount of construction contracted for before June 13, 1940.

Financing Power for Defense

All of these measures to provide sufficient power for carrying out the program outlined by the Government for national defense will require an expenditure of capital greater than would be necessary for peace-time production even if prices of materials, equipment and labor remained unchanged from those prevailing before defense activities were begun. This is due to the extra precautions that must be taken to insure against breakdowns from whatever cause. Although during recent years some government measures have been barriers to private financing of capital goods industries, recently enacted laws have removed some of these obstacles, so that borrowing is made more convenient for those companies engaged in manufacturing products considered essential for national defense.

For instance in October the excess profits tax bill was approved which permits manufacturers to amortize new defense facilities out of taxable income over a five-year period. Also the Assignment of Claims Act of 1940 has been passed providing the necessary authority for persons having contracts from the government calling for payments in excess of $1000 to assign such payments to "a bank, trust company, or other lending agency, including any Federal landing agency."

Another enactment, known as the "Emergency Plant Facilities Contract" was drawn up by the National Defense Advisory Commission and in a broad sense is a contract that can be executed by the government contracting officer and the private manufacturer and provides for the work to be done and the terms—cost, date of completion, etc.; for reimbursement to the manufacturer by the government in 60 equal monthly installments; for assignment by the manufacturer of these governmental promises to pay to the bank or other lending agency financing the work; and for retention by the manufacturer of title to the plant pending completion of payments at which time title passes to the government, except that the manufacturer may, if he wishes, buy the property back from the government at the original cost less depreciation, or, if he thinks this too high, at a price to be agreed upon by negotiation.

What The Defense Program Means

NATIONAL DEFENSE means many things to many people. To some it means a year or more in the army or navy; to others it means a job, or more wages; to the nation as a whole it means for a time at least a speeding up of industry, an increased national income, less leisure—in the end less butter and an entire change in our economic life.

Ideas about national defense vary widely. Some think of it in terms of an army of a million or more men, or 50,000 airplanes, or a two-ocean navy. Others think of it as intense industrial mobilization of men and materials capable of meeting any emergency. The isolationists regard it as a process of tightening up and drawing together of our own interests, of living within ourselves. The interventionists, quite oppositely, think of national defense as a way of extending our interests to include those of other nations.

Considering the speed of recent events, this confusion of thought on the subject is probably to be expected. Conditions prevailing one day are replaced by an entirely new set of conditions the next which bring forth new reactions depending upon one's interests. And not all of us can keep pace with events.

As long as the war was confined to Europe, our national defense problems were compartively simple. There was never a question of invasion and with the Panama Canal to provide a means of transit from one ocean to another our navy was adequate to protect our coast lines from attack by enemy fleets. In recent years the airplane had been considered as an instrument both of attack and of defense but few of us had any clear ideas as to how planes would be used in case of war. True, the feature writers had provided terrifying spectables of attacks on great cities but until the attacks on Madrid and London occurred we did not take these descriptions very seriously. The war was still in Europe.

An event of utmost significance occurred on April 9 of last year, however, which caused many of us to form new ideas about defense almost overnight. On that day Germany invaded Denmark. In itself this was startling enough for it marked the termination of the so-called phoney war and inaugurated the very real one now in progress. For us in America, however, the event was of even greater significance, for on that day the war jumped the Atlantic Ocean. On that day Denmark lost her sovereignty over Greenland and Greenland happens to be in America. Who will rule over America is the business of America.

A month later, on May 10, the German blitzkrieg flashed into the Netherlands and so on that day brought the war within striking distance of the Panama Canal. Look at the map; you will find the Dutch Island of Curacao just 700 miles from the Canal Zone. At present Hitler's swastika flies over Holland. The Dutch West Indies are still part of free Holland but if anybody else tries to take possession of these islands, then it immediately becomes the business of the United States.

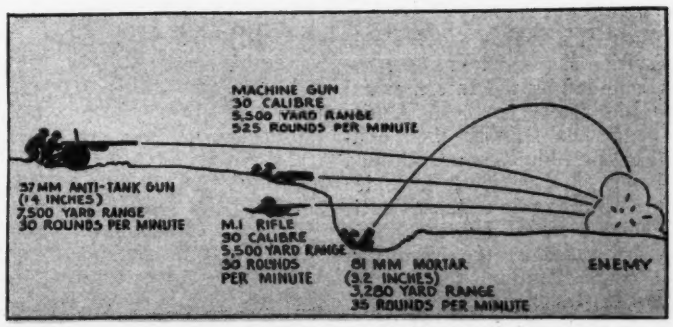
These two events entirely changed our defense requirements. Up to that time we had great faith in the security afforded by three thousand miles of Atlantic Ocean and in the strength of our navy, but with the possibility of enemy forces in control of bases in Greenland or in the Dutch or French West Indies, the Atlantic Ocean loses its security value.

The security of this hemisphere depends upon the maintenance of two fundamental conditions; first, a Panama Canal open for the transit of the United States fleet; second, an America that denies aggressors operation of bases anywhere in this western world.

If our problem was only the defense of the Atlantic Coast its solution would be comparatively simple. Traditionally our navy has always been our first line of defense and to that end we have always maintained a strong, swift and efficient fleet. Within American waters the U. S. Navy probably could oppose, successfully, any single fleet that could be brought against it. It is, however, a one ocean navy and its defense of the hemisphere is dependent upon the operation of the Panama Canal. Unless the fleet can be moved rapidly and in its entirety wherever it may be needed it loses its efficiency. It cannot be divided.

Under the conditions existing today, our navy is not sufficient to deny access by aggressor nations to all parts of this hemisphere. The recent trend in world affairs has disclosed possible naval combinations of greater superior strength to ours, superior in tonnage at least. True, the present program involves the construction of a two-ocean navy but it will take years to effect this increased naval power.

Nor is it definitely established that even a two-ocean navy would be sufficient to ward off attack. The case of Great Britain today demonstrates that even vastly superior naval power is not absolute protection against invasion. Warfare has definitely entered the third dimension. By this is not meant that continental United States is in immediate danger of attack by enemy air forces. The danger lies in the



U. S. Infantry Weapons

The Fleet in Action from the Air.
U. S. Navy Photo

possible establishment of enemy intermediate bases in Greenland, the West Indies, the north coast of South America and in Alaska and Hawaii.

Our first step in strengthening our defenses lies in the strengthening of the outpost bases which will guarantee the continued operation of the Panama Canal and at the same time deny access by other nations to strategic areas within striking distance of these bases. The continued operation of the Panama Canal gives our navy prompt access to both oceans.

Strategically, hemisphere defense does not mean what it implies geographically. There is no need for a rigid attempt to defend every bit of land mass in the Western Hemisphere, first because not all of it is worth defending strategically, and second, because all that is required is sufficient control of strategic points within the hemisphere to enable our planes and ships to guard vital areas and to prevent the establishment of "bridgeheads" by enemy forces in the areas listed above.

What this means is that our supervision should extend over the area bounded by the International Date Line from northern Alaska to the Samoa Islands, then eastward to the Galapagos; southward to about 40 deg. south latitude; then eastward again to the Atlantic and northward on a line running roughly through the Brazilian island of St. Paul and through the Azores to Greenland.

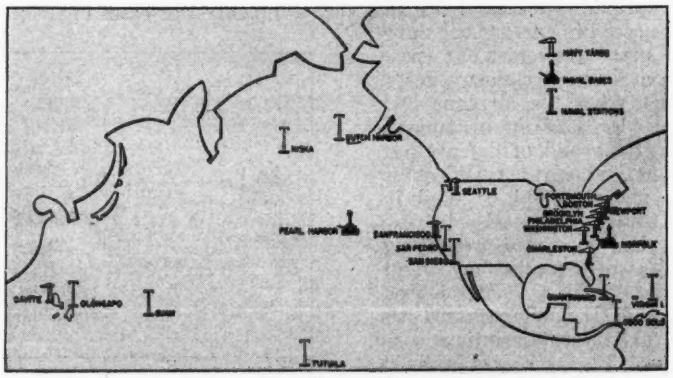
This, obviously, is a large order but it can be attained by the establishment of relatively few bases, properly situated, organized, defended and garrisoned and with the proper naval and air forces operating from them or capable of being sent to them.

Steps have already been undertaken to attain this control. The first duty of the army is the provision of garrisons in our overseas possessions. The Hawaiian Islands now constitute a real Gibraltar in the Pacific and recent additions to the garrison in the Panama Canal Zone have rendered it reasonably secure except from land-based air attacks. Material increases in our military forces in Puerto Rico have helped to convert the Caribbean Sea into virtually an American Lake, thus adding to the defense of the all-important Canal Zone. To render the latter entirely safe, however, requires additional bases in the Dutch West Indies and in the Galapagos.

In any scheme of hemisphere defense, the conditions existing in foreign areas must receive continuous and serious attention. Eternal vigilance is the price of freedom. The Caribbean is large and contains numerous out-of-the-way islands from which enemy operation can be directed. This involves our so-called neutrality patrol.

In contemplating our defense needs, we must recognize the fact that it is our job and our job alone. Much has been said and written about friendly coöperation with our Latin-American neighbor Republics. Many of these countries are friendly to us at the present time; others are not. Some of them remember things the United States has done in the past and that does not help matters. Despite their republic forms of government many of these countries are virtual dictatorships and while they may be sincere in their offers to coöperate, their internal government policies are too unstable to be relied upon. The Monroe Doctrine was proclaimed in order to prevent aggression of European and Asiatic powers against this hemisphere, but we made it and it will be up to us to see that its principles are carried out. We can count on little active help from other nations in the Western Hemisphere. We must play the dominant role.

The establishment of our outlying protective bases in addition to the fixed defenses means a huge air force. An air force of 50,000 planes is contemplated. It is easier to plan such an air force than to produce it, however. Few people have any conception of what it means. Industry just does not grind out airplanes automatically like cigarettes. Just recently defense



Our Far Flung Outposts

commissioner William S. Knudsen disclosed the disheartening fact that our hoped for production of 1000 planes a month by January 1941 was 30 per cent under this mark.

What an air force of 50,000 planes means in terms of flying and military personnel, industry and fuel, is shown by the accompanying diagram which appeared originally in the April 1940 issue of the Aeroplane (London). It represents basic air force of only 26,000 planes, just half the total number contemplated in our present program. The data represents the requirements of an air force of 13,000 combat planes and 13,000 non-combat craft of all metal construction and an average weight of 10,000 lb. These, take note, are not flying fortresses. The total replacements per year in wartime would require at least 117,000 airplanes and 221,000 engines to maintain the basic strength. As shown, part of the man power is used in the aircraft and accessories industry for research and the production of fuselages, engines, propellers, and instruments and the other part in auxiliary industries for the production of fuel, lubricants, uniforms and their distribution and transport.

So much for air defense, though we have merely hinted at its magnitude. While air power is of paramount importance, nothing that has occurred in the European War so far has invalidated the basic concept of sea power. The strength of our navy, therefore, is still of primary consequence. Today its strength consists of about 450 ships totalling 1,750,000 tons. During 1941 about 100 new vessels will be laid down which will increase our grand total to 2,213,000 tons. With the completion of the 84 fighting ships of 339,000 tons requested by Congress, our potential is something like 2,612,000 tons—by far the largest single naval fleet in the world.

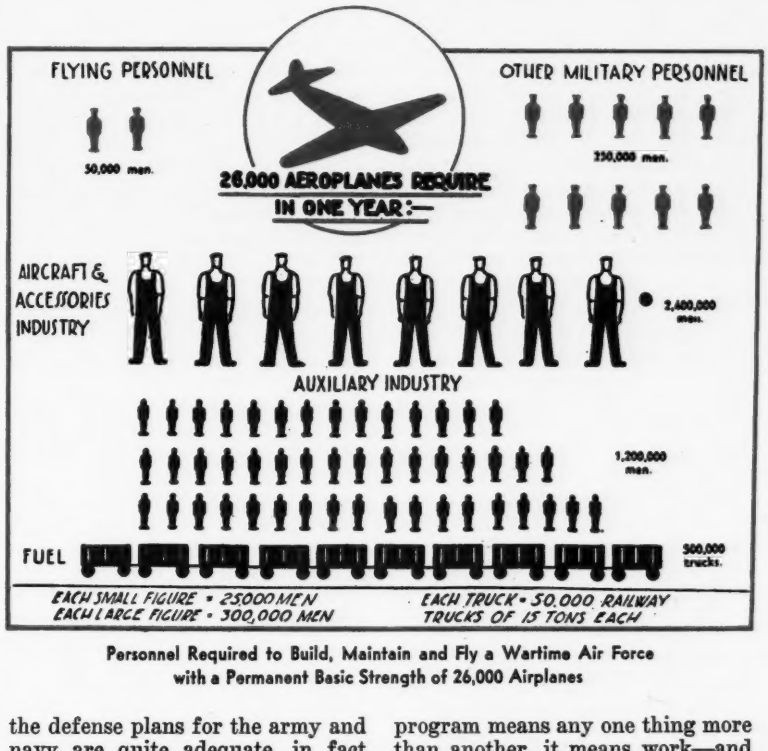
At the present time the total tonnage of our potential enemies (Germany, Italy, Russia and Japan) built and under construction, is about 2,500,000. The combined sea power of all four nations is, therefore, somewhat superior to our potential power, but one must go beyond statistics to evaluate the possible effect of this superior tonnage. Russia is negligible as a sea power; her submarines could be an irritant but it is doubtful if her principal units are seaworthy enough to cross the oceans. Of Italy's naval prowess, little need be said. Events in the Mediterranean in recent months have been such as to effectively discount Italy's influence in naval warfare. Germany's ships for the great part have small cruising radii, though some units are formidable long-range weapons. Japan's navy also has been built primarily for service in the far East.

It is quite evident then, that the defense plans for the army and navy are quite adequate, in fact under proper organization a much smaller force would be adequate. This is fortunate, for, as mentioned above, it is much easier to plan air forces of 50,000 planes and two-ocean navies than it is to construct them.

With respect to the army aside from those branches which garrison the overseas bases, the immediate need is for cantonments, clothing, supplies and military training equipment. The immediate protective need is for a small, adequately trained, properly armed, highly mobile seasoned force capable of acting instantly and anywhere in the event of emergency. The triangular or streamlined divisions organized recently, as compared with the World War divisions, have an increase in fire power coupled with a decrease of nearly two-thirds in personnel. Mobility has been greatly accentuated. The triangular divisions contain no animals of any kind, all loads being drawn by automotive equipment.

With the organization of additional such units and mechanized cavalry brigades, the problem of building up a large standing army and a large trained reserve force can be gone about at an accelerated pace.

In conclusion, it must be emphasized again that if the defense program means any one thing more than another, it means work—and sacrifice. While we have power and machines, it still takes human beings to operate and direct them. One thing above all, we must not let our selfish personal interests stand in the way of what has to be done. It will be the tendency for us to place too high a value upon our stocks and bonds—and our butter. As a noted French statesman and journalist told American audiences recently, the French people made that mistake —they thought too much of the value of their stocks and bonds. But, as he pointed out, after it was too late they discovered that the stocks and bonds proved not worth saving. In the end they were valueless. This same Frenchman gave another good piece of advice, and that was to do too much rather than too little. "If you make mistakes," he said, "make the mistake of doing too much. We did too little."



Personnel Required to Build, Maintain and Fly a Wartime Air Force with a Permanent Basic Strength of 26,000 Airplanes

ORGANIZATION
Of The Defense Program

SIX TIMES since 1775, when the shots at Concord roused the colonies from Maine[1] to Georgia, this nation has faced general military mobilization. Each time has seen a progressive change from the "Rabble in Arms" with muzzle loaders, light field pieces and privateers through the era of "Wooden Ships and Iron Men," the gattling gun, ironclads and captive balloons, to semi-automatic rifles, machine guns, long range cannon, airplane, floating and flying fortresses, mines, tanks and chemicals.

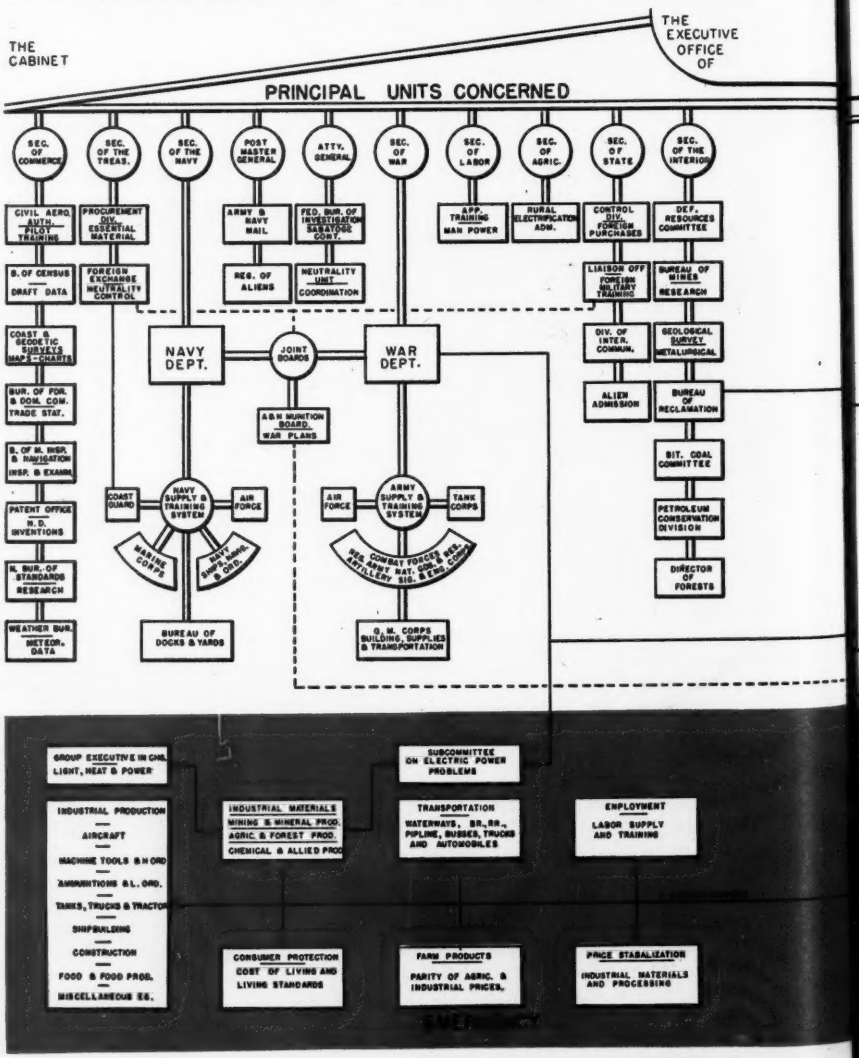
All these have been combined into "blitzkrieg" and "total war," in which the civilian population takes as much punishment as the fighting forces, with propaganda and mass psychology used as effectively as guns. No longer can an army live off the country, depending on a loosely knit industry only for a small supply of powder and shot, nor can a navy be created overnight by throwing a few cannon on merchantmen.

Manpower itself, in the form of infantry with light arms, remains the backbone of army forces. However, the striking power, which opens the way for effective use of infantry in offensive and defensive action, lies with machines in the form of fast mobile transportation, artillery, tanks, airplanes and communication systems.

During action the machine plays an equally important part for supply and control. The fate of the Polish army units, blinded by destruction of its airforce and confronted by motorized German units guided by airplanes through a highly organized communication system, is an excellent example of the ineffectiveness of manpower alone. France provides the same object lesson for the German mechanized units and parachute troops crossing the front, disrupted communication and supply lines to reduce the vaunted French army to a disorganized mass of individual units.

The importance of supply lines has increased directly with improvements in the size and firing rate of field armament. A rifleman carries 136 rounds of ammunition weighing almost 10 lb. The combat train vehicles carry about the same amount of ammunition together with one day's food and water. The rate of firing of the 1903 model Springfield is from 7 to 10 per minute, the new semi-automatic rifle from 15 to 30, so that under extreme conditions, the ammunition immediately available can be measured in minutes.

In the field artillery, conditions are even worse. The light mobile 75 mm. gun for instance, at a sustained rate of firing for 3 hr., will use 500 rounds of ammunition weighing over 5 t. While the immediate supply problem of the Navy is not so critical, due to greater storage facilities, man-

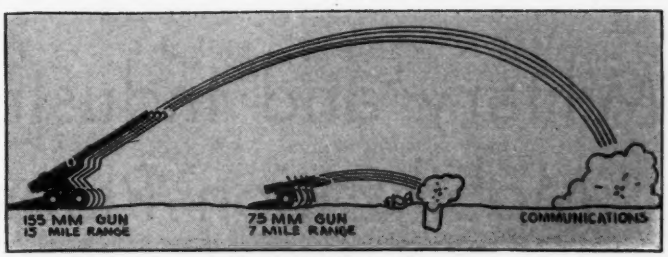


[1]Then part of Massachusetts. The original thirteen colonies were (in the order representatives signed the Declaration of Independence) Georgia, North Carolina, South Carolina, Maryland, Virginia, Pennsylvania, Delaware, New York, New Jersey, New Hampshire, Massachusetts, Rhode Island and Connecticut. The constitution drawn in 1787, went into effect in 1788, but was not ratified by North Carolina until 1789 and Rhode Island until 1790. Vermont, 1791, was the first new state admitted. Maine in 1820 was the tenth.

power is useful and effective only as control for the machines—of the guns to give fire superiority, the turbine for maneuvering and the airplane for scouting.

Continued effectiveness of both combat branches depends, therefore, on a well organized civilian industry, the importance of which has increased with each successive war. The military policy of the United States has always been defensive, however, with the public openly antagonistic toward a large standing army during peace time. As a result the organization of civilian activities has always lagged behind the actual requirement and the transition from peace to wartime conditions has always been one of hectic unorganized emergency.

This reached a peak during the last World War and it was not until the Armistice that any degree of unification and co-ordination was achieved. Fortunately,



U. S. Field Artillery

in spite of successive waves of pacifism that swept the world during the post war period, lessons learned then have been kept alive, the organization improved and plans perfected largely on the basis of the National Defense Act of 1920.

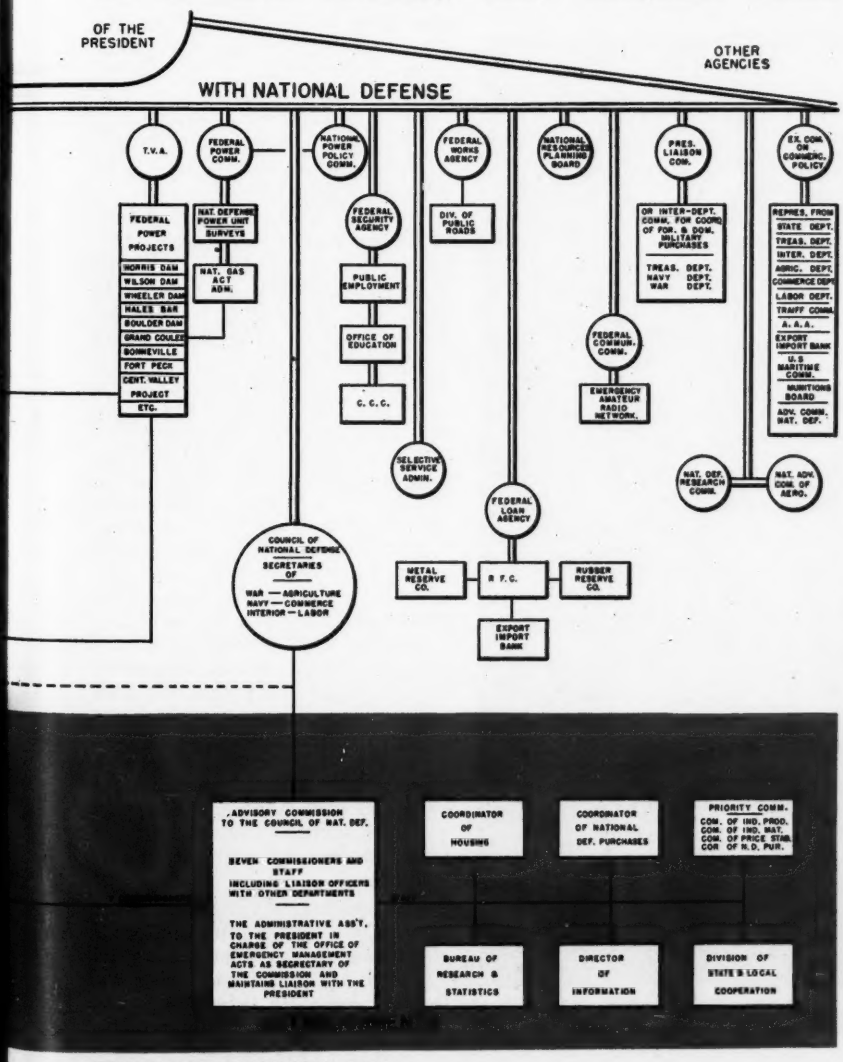
Laboring under tremendous handicaps of niggardly appropriations, restricting legislation and public criticism, the professional groups charged with this responsibility accomplished miracles. Foreign technical developments were followed closely, experimental work carried on with airplanes, tanks, anti-aircraft guns, chemical warfare equipment and other new and old armaments.

Stores of essential raw materials to meet defense needs were built up. Industrial plants were surveyed, earmarked for specific use and in many cases given "educational orders" to develop skill and experiences in production. Paper plans for recruiting manpower through the draft were perfected.

When the emergency came, the plans went into operation almost overnight with practically no transition disturbance. The War and Navy Departments knew what they wanted, why they wanted it and where it could be produced. With sufficient time, when and how this equipment actually materialized would have been taken care of automatically by present government agencies.

In an emergency, the when and how this can be accomplished in the time available with minimum disturbance to normal production, is made the responsibility of an emergency civilian organization centered around the Advisory Commission to the Council of National Defense.

True, the program is not being rushed through quite as rapidly as if actual war existed and last minute changes of a minor nature have been necessary. For instance, the medium tank program was delayed due to design changes felt necessary as the result of experience in Flanders during the French collapse. Again the need for a two ocean navy was brought about by very recent events. Not until after the Polish invasion and the attempted invasion of England was the full importance of the air force effectively demonstrated, although long before this airplane production capacity was a salient feature of the National Defense Plan.

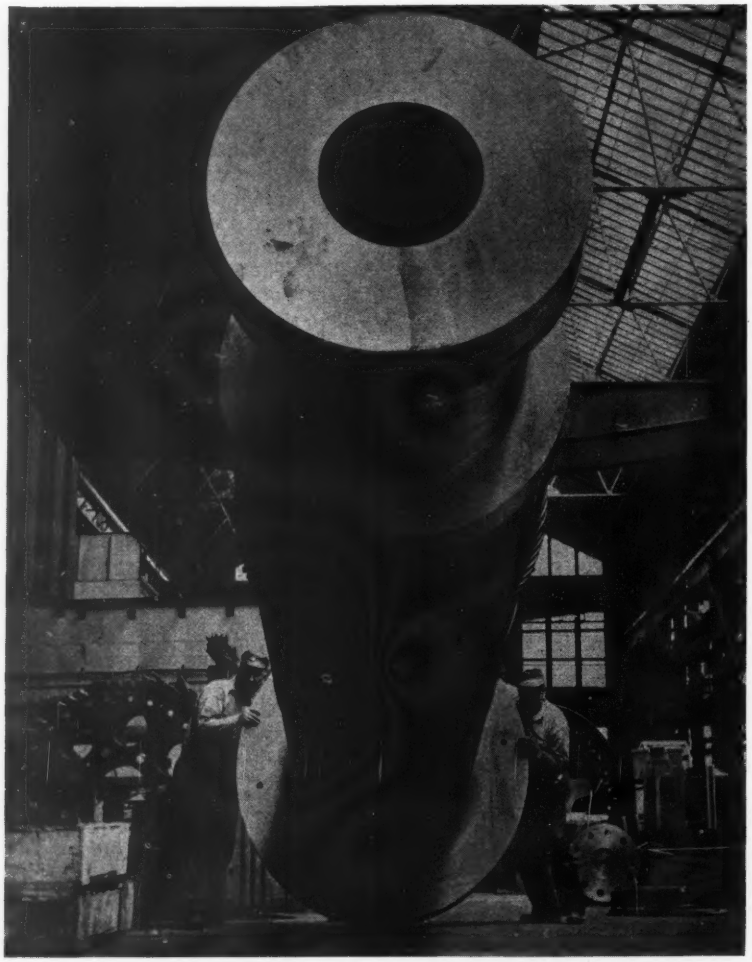

OF THE PRESIDENT
OTHER AGENCIES
WITH NATIONAL DEFENSE
T.V.A.
FEDERAL POWER COMM.
NATIONAL POWER POLICY COMM.
FEDERAL WORKS AGENCY
NATIONAL RESOURCES PLANNING BOARD
PRES. LIAISON COM.
EX. COM. ON COMMERC. POLICY
FEDERAL POWER PROJECTS
NAT. DEFENSE POWER UNIT SURVEYS
NAT. GAS ACT ADM.
FEDERAL SECURITY AGENCY
PUBLIC EMPLOYMENT
OFFICE OF EDUCATION
C. C. C.
DIV. OF PUBLIC ROADS
SELECTIVE SERVICE ADMIN.
FEDERAL COMMUN. COMM.
EMERGENCY AMATEUR RADIO NETWORK
OR INTER-DEPT. COMM. FOR COORD. OF FOR. & DOM. MILITARY PURCHASES
TREAS. DEPT. NAVY DEPT. WAR DEPT.
REPRES. FROM STATE DEPT. TREAS. DEPT. INTER. DEPT. AGRIC. DEPT. COMMERCE DEPT. LABOR DEPT. TRAFF COMM. A. A. A. EXPORT IMPORT BANK U. S. MARITIME COMM. MUNITIONS BOARD ADV. COMM. NAT. DEF.
NAT. DEF. RESEARCH COMM.
NAT. ADV. COM. OF AERO.
COUNCIL OF NATIONAL DEFENSE
SECRETARIES OF
WAR — AGRICULTURE
NAVY — COMMERCE
INTERIOR — LABOR
FEDERAL LOAN AGENCY
METAL RESERVE CO.
R. F. C.
RUBBER RESERVE CO.
EXPORT IMPORT BANK
ADVISORY COMMISSION TO THE COUNCIL OF NAT. DEF.
SEVEN COMMISSIONERS AND STAFF INCLUDING LIAISON OFFICERS WITH OTHER DEPARTMENTS
THE ADMINISTRATIVE ASS'T. TO THE PRESIDENT IN CHARGE OF THE OFFICE OF EMERGENCY MANAGEMENT ACTS AS SECRETARY OF THE COMMISSION AND MAINTAINS LIAISON WITH THE PRESIDENT
COORDINATOR OF HOUSING
COORDINATOR OF NATIONAL DEF. PURCHASES
PRIORITY COMM.
COM. OF IND. PROD.
COM. OF IND. MAT.
COM. OF PRICE STAB.
COM. OF N. D. PUR.
BUREAU OF RESEARCH & STATISTICS
DIRECTOR OF INFORMATION
DIVISION OF STATE & LOCAL COOPERATION

Military and Industrial Mobilization Plans

DRAWING upon lessons learned during the World War, modernized as found desirable by field observations in Spain, China, Finland, Poland and Flanders and modified to fit present national policies, the government has completed plans to meet any degree of national military emergency that may arise.

These plans, leading up to what has been popularly termed M-Day, is really in two parts: The Protective Mobilization Plan, dealing primarily with the distribution, organization and expansion of the present armed forces of the nation; and the Industrial Mobilization Plan dealing with organization of industry to produce armaments under emergency conditions.

Had present world conditions been foreseen and had our post war military policies been less dominated by pacifism, so that stocks of equipment could have been built up over a period of years, the first part of the plan would have been entirely adequate. The problem would then be reduced to procuring additional men, mobilizing them into units, and training them to use the equipment effectively as combat forces.



The Big Guns of Industry. A 130,000 lb. Generator Shaft for a 75,000 hp. Turbogenerator in the shops of the General Electric Co.

The Protective Mobilization Plan

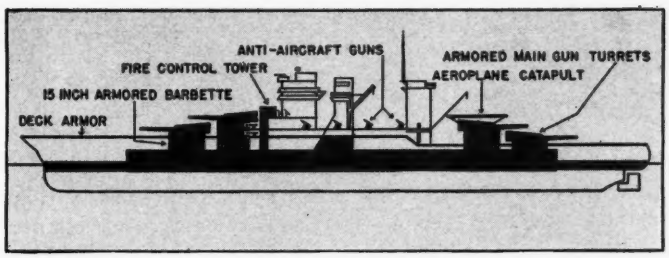
While for over a century the United States had no definite military policy, this condition was changed in 1920. Now the military force in time of peace consists of a small protective force consisting of the regular army and the National Guard, organized so as to be expanded rapidly in emergencies. The combined force, augmented from the Officers Reserve Corps, the Regular Army Reserve and volunteer enlistments, is known as the Initial Protective Force.

In co-operation with the Navy, organized along somewhat similar lines with a trained reserve, this organized force distributed in strategic positions throughout the United States and its possessions, would defend this nation against hostile attack until it was possible to recruit, equip and train additional units needed to give a well balanced military force of approximately a million men.

Further legislation passed only last year and utilizing the draft plan formulated during the World War would approximately double this force by adding a Selective Service Army. The plans have been further expanded to provide for a two ocean navy, something considered in the past but made necessary only by recent developments in Europe and the Far East.

Weakness of the Initial Protective Force to meet a real emergency lay not in the plan itself, but in congressional action which reduced appropriations and authorized personnel far below that contemplated in the National Defense Act of 1920 upon which the plan was built. In the absence of a definite national policy, the plan had to consider any eventuality from every section of the globe, and was of necessity largely a paper plan. Furthermore it had to be flexible, capable of adaption to the surprise limitations so often imposed by authorizing legislation.

The success of the plan is predicated on the assumption that equipment for at least the Initial Protective Force, and preferably for the complete balanced forces provided for in the Protective Mo-



Battleship Armament

bilization Plan, is immediately available. The time lag between the awarding of contracts and the actual delivery of critical necessities—weapons which cannot be procured from commercial firms—amounts to a period of from 1 to 2 yr.

In anticipation of this need the Army, and Navy too, is now obtaining a large part of this critical equipment as a result of legislation passed by the 76th Congress. Had the emergency developed less rapidly, or, had it not been so intimately concerned with supplies for Great Britain, it is quite likely that the whole thing might have been carried through without resorting to the second or industrial phase of the plan.

The Industrial Mobilization Plan

This part was formulated to mobilize the industrial manpower of the nation in support of the combat forces and give a minimum disturbance in shifting from a peacetime to wartime basis. It was evolved from years of study by the Army, Navy and Industry and takes into account the procurement plans of the two branches, other government agencies and the needs of the civil population. The plan is intended to insure an efficient use of raw materials, labor, manufacturing facilities, management, power, finances, and transportation with an equitable distribution of the burdens of war.

Over 20,000 manufacturing plants have been surveyed to determine what they can best produce and in what quantities. Some 10,000 of them were earmarked for war production, their managers and proprietors informed of the tasks to be imposed upon them. One effective means of doing this was by awarding "educational orders" for limited amounts of noncommercial products. In many cases this involved setting up special equipment and training skeleton crews.

Closely related to these industrial surveys were power surveys to insure that utility systems and individual industrial plant generating capacity was adequate to meet the demand. Another phase has formulation of definite standards to insure addition of utility capacity under emergency conditions with the minimum of delay and disturbance.

Still another phase of activity was in connection with transportation, to forestall the breakdown of the railroad system which characterized the last war and to preclude the necessity for government operation. The breakdown at that time was not due to lack of facilities or railroad organization, but to the lack of coördinated industrial activity which kept thousands of loaded freight cars out of active service. Should such an emergency again exist, it will be kept in control by a system of shipment embargoes—no freight cars loaded until warehouse facilities are available at the terminus.

While the details of these plans have been largely up to the Joint Army and Navy Munitions Board, as the most interested party, they have been worked out with the assistance of, and based on, a large number of regular government agencies, augmented as needed by an advisory civilian board as described in later articles.

Peacetime Organization

AS A RESULT of gradual evolution, the National Defense Program as its exists today is actively participated in by some 33 main agencies and over 80 separate and distinct sub-agencies involving practically every department of the Federal Government. These cover every phase of national activity from the actual combat forces to the public health of civilians. Many of the agencies play only a minor part, others are coördinating or advisory bodies to eliminate overlapping of responsibilities and duplication of effort. Some are permanent agencies, some come into being only as temporary units during emergencies.

Of the permanent agencies, three departments have direct charge of the organization, training and routine supply of the combat forces. The Army comes under the War Department, the Navy, including the Marines, under the Navy Department, while the Coast Guard, in peacetime under the Treasury Department, under war conditions or at the command of the President, becomes part of the Navy.

Each of these four combat branches, Army, Navy, Marines and Coast Guard, are organized as separate and distinct units each for a different purpose. It is obvious, however, that in many cases the functions or activities overlap. For instance, coast defense comes under the Army but is of vital interest to the Navy; development of an air force, armament and munitions is largely a common problem.

Coördination is obtained through a number of agencies among which are four Joint Army and Navy Boards. The first deals with problems involving coördinated action between the two branches, the second, with economies that can be effected by the elimination of overlaps and simplification; the third with the procurement of munitions and supplies, and the fourth with the development and employment of the air forces.

In this last, the independent National Advisory Committee for Aeronautics and the Civil Aeronautics Authority (Dept. of Commerce) play an important part. The former primarily in connection with aeronautical research and development, the latter in connection with airports, navigation aids and facilities, and pilot training.

U. S. Naval Airplanes during Maneuvers off the Pacific Coast

Several other Department of Commerce divisions play an equally important part in coöperating with one or both branches. The Bureau of Standards carries on scientific investigations, tests materials, develops commercial standards and specifications as well as conducts confidential investigations for the Army and Navy. The Weather Bureau collects and supplies meteorological information. The Coast and Geodetic Survey (which may in an emergency be transferred to the Army or Navy by the President) supplies or coöperates in the preparation of nautical and aeronautical charts.

Several divisions of the Interior Department play important roles, primarily in connection with natural resources, metals, water power and fuels. Of these several will be discussed later, the principal direct tie-in being the Geological Survey which investigates the extent and location of mineral and water power resources and also supplies topographic maps of the country for military use. The Public Roads Administration, now part of the Federal Works Agency, has long coöperated directly with the Water Department on National Defense highways throughout the country.

Many materials, metals and fuels are essential to present day Army and Navy needs. As a rule, these can be depended upon through regular commercial channels and different agencies discussed in an earlier article. Certain strategic materials, principally imports, are of direct concern to the armed forces and steps have been taken to build up surpluses for war use. Notable examples of this are tin, manganese and rubber, acquired and stored by the Metals Reserve Co. and the Rubber Reserve Co., both of which, organized with a capital of $5,000,000 each, come under the Reconstruction Finance Corporation of the Federal Loan Agency. Another example is opium for medical purposes, purchased and stored by the Treasury Dept., together with other critical and strategic materials made at the direction of the Secretary of War or the Secretary of the Navy.

Other agencies dovetail into the peacetime organization with provision for emergency expansion in war time playing a less direct, but not always less important part. The Federal Bureau of Investigation (Dept. of Justice) coöperates counter espionage and protection against sabotage. The Post Office Department handles Army and Navy mail. The Patent Office (Dept. of Commerce) has a special defense committee for collaboration with the War and Navy Departments. The Bureau of Census collects data on individuals and strategic industries. It also supplies the data upon which detailed plans for the Selective Service plans were based.

Among other things the Department of Labor has committees to advise on apprenticeship training in industry, conservation of man power and the placement of women. Closely related is the public employment offices of the Social Security Board (Fed. Sec. Agency) for the recruiting of labor and the Civil Service Commission for recruiting and certifying eligibles for appointments coming under Civil Service. An example of coördinated action of different agencies was the combined studies of the War Department, Labor Department and C. A. A. in 1939 to map out expansion plans for the airplane industry.

Other agencies are set up to deal with less direct phases; national food problems; agriculture; rural electrification; organization of radio amateurs into an emergency communication system; etc. Power and fuels is a problem in itself and was covered separately in an earlier article.

With the assistance and coöperation of these various agencies the War and Navy Departments are charged with supervising and maintaining the defense forces in accordance with demands of our national and foreign policies. The foreign policies upon which the military and naval needs depend are set jointly by the President, the Congress and the State Department. Thus the State Department plays an extremely important, but little known, role in National Defense, since this is one phase of foreign policy.

By means of diplomatic, military, naval and commercial representatives, the State Department maintains close contact with all foreign countries. Dissemination of information and closer coöperation between departments was further improved late in 1939 by the establishment of a Liaison office under the Under Secretary of State. This office has further responsibility in connection with sending military, naval and aviation missions to other American Republics and coördinating arrangements for training officers of other Republics in U. S. military and naval service schools.

Since 1936 the defense functions of the State department have been further broadened to include supervision and control of imports and exports of armaments and military supplies such as tin and steel scrap and helium gas, and just recently machine tools. This comes under the Division of Control, the chief of which is in turn executive secretary of the National Munitions Control Board responsible for technical relations with the appropriate divisions of the War and Navy Departments and the President's Liaison Committee on Arms Purchases. This latter committee, also known as the Federal Inter-Departmental Committee of Foreign and Domestic Military Purchases is considered in greater detail in the next article in connection with the Advisory Committee on National Defense.

Because of the recognized importance of economic aspects in modern war, the Executive Committee on Commercial Policy was formed in 1933 to coördinate the commercial policy of the country. The organization of the committee is typical of the cross representation by which coördination of different departments is obtained.

The Committee meets weekly and consists of representatives of the Departments of State, Treasury, Agriculture, Commerce and Labor; the Tariff Commission; Agriculture Adjustment Commission; the Export-Import Bank; the Maritime Commission; the Joint Army and Navy Munitions Board; and others that the President may approve from time to time for definite or indefinite periods.

In this connection the role of the Export-Import Bank of Washington now organized under the Federal Loan Agency originally with a capital stock of $75,000,000 is important. The purpose of the bank is to finance exchange of commodities between the U. S. and possessions "and any foreign country or its agency or nationals," sufficiently broad to give financial backing for almost any real or fancied need of national or foreign policy.

Under the joint action of all these agencies, the War and Navy Departments through the Joint Army and Navy Munitions Board formulated the general plans for Protective and Industrial Mobilization mentioned earlier. The latter deals principally with the emergency production of military and naval supplies demanding coördinated action of all industries. Responsibility for this coördination rests largely with a special civilian emergency advisory board.

While this board or commission, outlined in detail in the next article, is strictly an advisory body with limited direct authority, its indirect power through regular channels and agencies is now apparently entirely adequate to meet any need. In fact it was made almost absolute by Sec. 9 of the Selective Service Act empowering the President to enforce production and priority orders on military and naval equipment.

Emergency Civilian Organization

AS BELATED RECOGNITION of the part industry plays in modern warfare, Congress created in 1916 the Council of National Defense for "coördination of industries and resources for the national security and welfare . . . in time of need." This council of six cabinet members is empowered to nominate" . . . an advisory commission (of) . . . not more than seven persons, each of whom shall have special knowledge . . ." During the first world war this Council was reorganized into the War Industries Board.

In 1940 the Advisory Commission to the Council of National Defense (or the shorter National Defense Advisory Commission) was reestablished to cope with the emergency rearmament program. This consists of the seven commissioners or advisors mentioned above, together with additional special advisors, liaison officers and subordinate bodies needed to facilitate the work. The seven main divisions, each with a commissioner, are: industrial production; industrial materials; employment; farm products; transportation; price stabilization; and consumer protection.

The Commissioner of Industrial Production is in charge of production of defense material with particular emphasis on the elimination of industrial bottlenecks. Several divisions are provided covering; aircraft; machine tools; ordnance; tanks and trucks; shipbuilding construction; food and food products; and miscellaneous equipment.

The Commissioner of Industrial Materials' duty is to insure an adequate and continuous flow of raw materials from the source to factories and other points of fabrication. These products are roughly grouped into: mining and mineral; agricultural and forest; and chemical and allied products. Power, while not strictly a material, is an essential of industrial production and fits logically into this group, being included in the Minerals and Metals division under a group executive in charge of Light, Heat and Power. In addition there is the subcommittee on Electric Power Problems to deal with the broader phases of the power problem. This subcommittee for instance played an important part in the recent decision to extend TVA generating capacity beyond the byproduct stage in order to meet the emergency demands for aluminum.

The Commissioner of Employment is in charge of labor supply problems including the training of men for non-combat duties. It is said this latter activity already involves the schooling of over 1,000,000 young men, for, in spite of present unemployment there is a shortage of skilled labor in many lines and the training problem is tremendous.

The Commissioner of Transportation is responsible for coördinating transportation facilities including waterways, short haul railroads, pipe lines, interurban lines, bus, trucks, private automobile and domestic air transportation, to insure prompt carriage of men and materials.

The Commissioner of Farm Products is responsible for accommodating national agricultural policies to defense, particularly with maintenance of the party system of agricultural and industrial prices. In this he must

work closely with the Commissioner of Price Stabilization concerned primarily with prices of industrial raw materials and their fabrication. Both of these are of vital importance to the general public whose interests are the chief concern of the Commissioner of Consumer Protection charged with the prevention of undue increases in the cost of living and maintenance of living standards.

In addition to the seven commissioners there are several bureaus organized to facilitate the main activities of the Commission. The Bureau of Research and Statistics facilitate the flow of requests between the Commissioners and regular departments of the government, trade associations and business enterprises. The Housing Coördinator plans for the housing in accordance to the requirements and standards of the different commissioners. The Division of State and Local Coöperatives serves as a channel of communication and information between the Commissioners and local bodies.

More recently a Priority Commission was set up, supposedly with power to enforce priorities up to the point of actually taking over plants. This power rests with the President in accordance with Section 9 of the Selective Service Act.

This Priority Commission is made up of four commissioners and the coördinator of National Defense Purchases, also one of the civilian staff of the advisory commission. Coördination in relation to private purchases and export is obtained through the Administrator of Export Control (closely allied with the State Department Division of Control) and also with the Interdepartmental Committee for Coördination of Foreign and Domestic Military Purchases. This last, also known as the President's Liaison Committee, was created by executive order in 1939 as an informal committee to prevent conflict of domestic or foreign military orders with requirements of this country. It is made up of representatives from the Navy, War, and Treasury Departments, the latter serving as liaison officer between the Committee and the President.

The above agencies of the Advisory Committee cover all phases of emergency civilian activity except research. This is taken care of by a National Defense Research Committee set up by the Council of National Defense in June, 1940. It was established to correlate and support scientific research on mechanisms and devices of warfare with the exception of flight which is included in the activities of the National Advisory Committee for Aeronautics (established in 1915). One of the first activities of the N. D. R. C. was an $8,400,000 laboratory recently started at Cleveland, O., for airplane engine research.

While the task of the Advisory Commission as a whole is clear cut and definite, it remains an advisory body for the President and heads of the executive department. Its direct authority is questionable and its proper functioning depends largely upon voluntary coöperation of industry.

A New Superboard

In the heat of an emergency this has proved adequate for sectional and political differences are largely subjugated to the national welfare. How it will stand up over an extended period remains to be seen. Many feel that it will have to be further strengthened and centralized under the direction of a chairman, other than the President, to eliminate the cumbersome necessity for unanimous approval for decisive action.

When the commission was formed, the intention was that the President would be the chairman. In peace time this has not worked out because of his other duties, although as organized the contact is close through the Administrative Assistant to the President who acts as secretary to the Advisory Commission.

Unless the Defense Program bogs down, or actual war starts, it is not likely that major changes or reorganization will be made. After all, the commission is an emergency device which will soon have served its purpose. The more informal and decentralized it remains during the emergency period the easier it can be disbanded, and its functions turned over to regular government agencies after the emergency is over.

As a step in the direction of greater freedom of action and increased responsibility, however, the President indicated late in December that a new superboard would be created by executive order. This new board, to be known officially as the "Office for Production Management", will probably consist of initially The Commissioners of Industrial Production and Employment and the Secretaries of War and Navy.

While the duties and powers of this new board are as yet not fully known, it is expected that its powers will be quite broad and that decisions can be made without waiting for executive approval. Apparently, however, the board still lacks a definite chairman and important decisions to be effective must be unanimous.

Grand Coulee a major link in power supply

POWER USAGE INCREASES SHARPLY

BUSINESS ACTIVITY accompanying the National Defense Program, the placing of foreign war orders and the buying by private business for inventory purposes, has been reflected in a power increase of 11 per cent over 1939 according to the E.E.I. Sales of industrial power showed the greatest gains, 16½ per cent; retail commercial sales increased 7 per cent; and sales for residential service 10 per cent.

Generating capacity proved ample to supply the highest peak loads of the year and the large new installations under way give assurance for the future of an adequate power supply, except perhaps in isolated locations. Practically without exception new army cantonments, camps, air bases, and munitions factories, located throughout the country, were within reasonable reach of existing power lines.

Generating capacity added in stations contributing to the public supply of 1940 amounted to 1,790,000 kw. with a net gain in generating capacity, after deducting for equipment retired from service or reduced in capacity rating, of 1,380,000 kw. This brings the total generating capacity at the end of the year to 40,330,000 kw.[1]

Six Million Kilowatts Under Way

Generating capacity to be installed in 1941 by plants contributing to the public supply amounts to 3,412,000 kw. In 1942 there will be an additional 2,302,000 kw. according to reports so far received, and new installations are already being scheduled for 1943 and 1944 as well. Because of the part they play in the defense program, it is of interest to note that isolated industrial steam plants,[2] which added 120,000 kw. of capacity in 1940, will add 251,000 kw. in 1941, and have already scheduled the installation of 110,000 kw. in 1942. Thus the grand total of new capacity which will be installed in the next 2 yr. approximates 6,000,000 kw.

For the country as a whole, the sum of the peak loads on the various systems was about 10 per cent above the similar figure for last year, and the total installed generating capacity of the country was about 30 per cent in excess of the sum of the individual peak loads. This nationwide peak load figure is significant only as an indication of the trend of load growth and of its approximate relation to total installed capacity. The excess represents unused capacity which is available to carry additional load and capacity held in reserve against breakdowns. It also includes hydro capacity which can be depended upon only a part of the year, when there is sufficient stream flow. It does not, however, include overload capacity of generating equipment, which can be called upon and is an important and substantial resource in case of need.

So far as can be foreseen at this time, except perhaps for isolated situations, there will be an ample supply of power in 1941 and in 1942 to operate all the new munitions factories now projected. The increased power use which will come from employing more shifts in existing factories does not add appreciably to the peak load on power systems. If still further extensions of munitions factories should be undertaken, new generating capacity can be added to supply them as fast as they are built.

Construction Budgets

According to preliminary reports, construction budgets for the privately owned electric utilities for 1941 will exceed 1940 construction expenditures of approximately $580,000,000 by some $100,000,000. This forecast does not include the 1941 construction expenditures which will be made by public agencies for power purposes.

Output of electricity[1] in 1940 by all agencies contributing to the public supply, amounted to 140,750,000,000 kw-hr., compared with 126,666,317,000 in 1939. Fuels produced 94,500,000,000 kw-hr., an increase of 13 per cent over the previous year, and water power produced 46,250,000,000, an increase of 7½ per cent over 1939. Water power production was stimulated by improved rainfall during the second half of the year. Net sales to ultimate consumers (as contrasted to production figures above which include transmission and distribution losses) increased from 105,768,000,000 kw-hr. to 118,500,000,000. About half of this was to large industrial power users who in 1940 used 59,550,000,000 kw-hr. as compared to 51,108,000,000 in 1939.

Revenues and Expenses

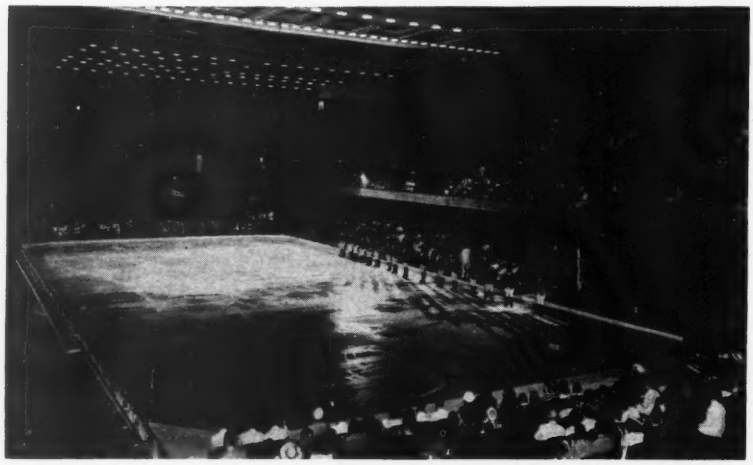
Total revenues approximated $2,413,000,000 for 1940, an increase of $124,000,000, or 5.4 per cent, over the previous year. None of this increased revenue, however, was carried over to balance available for the investor. Increased sales naturally made necessary increased generation. More coal was burned, and payrolls expanded. Virtually every dollar which was gained through increased sales of retail commercial and of industrial power (about $73,000,000) arising from the war emergency was taken away by increased taxes. Taxes rose $65,000,000 during the year to a new high figure of $405,000,000 and now represent over 17½ per cent of every dollar of gross revenue.

During the year most of the increase was in federal taxation, the result of the increase in the normal income tax from 18 per cent of taxable net in 1939 to 24 per cent in 1940. Therefore the net operating income was about the same as it was the year before.

The increasing tax and decreasing unit cost is well illustrated by the following figures. As far as domestic service is concerned, about 20 cents out of every dollar received from the customer goes to the various government agencies. Out of an annual bill of $36.27 there is some $7.25 concealed in direct taxes and the net bill of $29.02 is practically the same as the net bill one decade ago, although the kilowatt hours furnished the consumer have increased by 75 per cent.

[1]Statistics collected by the E.E.I. and F.P.C. are not directly comparable due to the inclusion of certain industrial and public works capacity in the latter. Thus the F.P.C. data summarized on p. 25 of the September 1940 issue shows a total capacity of 40,318,000 kw. at the end of 1939.

[2]Figures compiled by the Turbine Section of the N.E.M.A. show that orders for turbine generator sets from 10 to 7500 kw. capacity (for land installation, both utility and industrial) amounted to 415,680 kw. for the first 9 mo. of 1940 as compared to 147,583 kw. for the entire year in 1939. Similar figures for mechanical drive turbines (for land installation only) are 236,172 and 81,694 respectively.



The 61 by 120 foot skating rink for New Orleans' recent mid-summer Ice Carnival was sheathed in one-inch ice by direct expansion of Freon-12 in coils in the tank.

Direct Expansion Saves Cost On Ice Rink

OVERCOMING several unusual refrigerating problems in freezing a temporary 7400 sq. ft. ice rink during mid-summer for New Orleans' first Ice Carnival required special skill and engineering ingenuity. First cost was reduced, time saved and operating expense lowered by applying direct expansion of Freon in copper tubes embedded in the rink tank, instead of the originally proposed brine system. By expert planning, the entire installation using two 60-hp. hermetically sealed condensing units for freezing a one-inch thick crust of ice on the rink was completed in the record-making time of seven and one-half days.

The two-week Ice Carnival was staged in the largest centrally located auditorium, and it was necessary that any brine cooling system be located outside the building. Since the Ice Carnival was a short time show the first equipment was arranged to be put in and taken out without trouble and damage to the auditorium. The first idea was to locate compressor equipment and brine tanks on railroad cars placed on a siding at the rear of the building. This led to many difficulties and much expense. Based on his wide experience in Freon-direct expansion refrigeration systems, Chief Engineer Walter Taylor of the Equitable Equipment Company, suggested the startling idea of using Freon refrigerant refrigerating equipment and freezing the rink ice by direct expansion of this refrigerant in copper tubes in the rink water tank. Cost estimates indicated that this could be done more cheaply than the original plan and would result in a cheaper operating cost. The new idea was accepted and by careful planning and coördination the installation was completed in a trifle more than a week.

The rink was 61 ft. wide and 120 ft. long with an extension on one side as an entrance of 5 ft. wide and 20 ft. long. A 9200 lb. galvanized tank of these dimensions was made with approximately 1000 linear feet of locked and soldered joints. First an insulation pad of resin paper, a layer of one-inch locked roofing Celotex, a layer of 15-lb. tarred felt and finally another layer of locked one-inch roofing Celotex was put on the auditorium floor. The water tank sat on this insulation pad. A 6-in. high framework was built around the side of the tank.

The cooling coils consisted of 29,120 lineal ft. of 5/8-inch O.D. Type L copper tubing of 20 ft. lengths. These tubes were spaced on three-inch centers and made up in coil sections of 16 tubes, 60 ft. long, three-inch centers. To feed these coil sections there were 30 expansion valves of the multiport type.

74 Tons Capacity

The 74-ton refrigerating system consisted of two Westinghouse sealless Freon-12 condensing units located in the basement. Each unit consists of a 60 hp., 8-cylinder hermetically-sealed refrigerant cooled motor type compressor, and a water cooled condenser. Each condensing unit weighed 4100 pounds and measured 92 7/8 inches long, 26 1/4 inches wide, and 49 1/4 inches high. The space available for these units was 12 feet by 12 feet.

Temporary electric power lines were run in from the main switchboard, temporary water piping for the condensers and temporary insulation of refrigerant pipes and installation of operating and safety control completed the installation. Installation was started Sunday, 2:00 P. M. and the system was charged with refrigerant by Friday, 9:45 P. M. On the following Sunday at 2:00 A. M., the rink was frozen and first rehearsal was at 2:00 P. M. At 8:30 that night, the Carnival started as scheduled.

Air Conditioning and Paint

Modern air conditioning and exterior paint seem on the surface unrelated. Exhaustive tests, however, have shown that the tendency of exterior paint to blister and peel is directly connected with modern construction as related to the demand for lower heating costs and more comfortable living conditions.

These experiments, conducted by Du Pont on some 450 houses throughout the country, established the fact that modern tight construction to keep out the outside weather, but with means provided to humidify the air within, causes moist air to migrate from the warm interior to the cold exterior of the wall or clapboards. Condensation then occurs causing a loss of adhesion during the winter months with consequent blistering and peeling of the paint film later.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

Hi Gang!

MY TWO BUDDIES who have been running this section of Power Plant Engineering since I relinquished the job a year ago were too smart for me—they dumped the whole job right back in my lap. I tried to sell them the idea of keeping it, emphasizing the prestige it would give them but they would have none of it, so here we are right back where we started. In many ways, however, I am glad to be back with you again and even at this early date things look promising. Already I have had an initial skirmish with that intellectual irritant, Pulverizer Pete and I have it on good authority that his famous Stooge is lurking just around the corner writing poetry, of all things. Pulverizer Pete's own Prize Contest appears in this issue and next month we will publish (provided the printer will set it) an example of the Stooge's poetry. Heaven help you. We also have a new department called "Shop Talk" where you fellows who like to take pictures can display your skill. One sad note, we just received word that our old friend, A. G. Solomon, died a few days ago. He was a contributor to Power Plant Engineering for 30 odd years and we shall miss his fine articles on refrigeration. We still have several of his unpublished articles in our files which will appear during the course of the year.

Now, if you will bear with me, let's get to work. A Happy New Year to you all.

Andrew Kramer

CONTENTS

The Maintenance of Practical Engineers 70
Random remarks about many things, success curves, lie detectors and exercise charts.

For the Plant Electrician 72
Maintenance and Installation of Fluorescent Lamps. By Merrill A. Radamaker
Proper Care and Maintenance of Electrical Instruments

Refrigerating Practice 74
An Automatic Tube Ice Machine

Shop Talk 75
Starting Tachometer
Good Housekeeping
Instrument Panel
Log Holder

Questions and Answers 76
An S.O.S. from the Philippines
How are Compressors Operated in Parallel?
Refrigerating Engineers, Please Note
What is Plugging?
Calculating Float Size
A Mechanical Version of Lincoln's Famous Question
How Can Boiler Scale Be Removed?
Pressures and Temperatures for CO_2 System
Three Phase Motor on Single Phase Current
Who's Got The Missing Link?

How Would You Do It? 78

Letters and Comments 82
"Verboten"
Pulverizer Pete Comes Out of Hibernation

Maintenance Chart for Practical Engineers 84

A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

The title of this article is misleading. True, the article does consider the subject of engineer maintenance but it arrives there only after a round about discussion of everything from success curves to Hindu lie detectors. It makes rather light reading, however, and after the ponderous discussion of National Defense in the first part of this issue, this, it seems to us, is quite desirable. More important, it provides with an excuse to publish Dan Gutleben's famous exercise chart —something we have been wanting to do for a long time.

THE MAINTENANCE OF PRACTICAL ENGINEERS

ONE OF OUR esteemed contributors recently sent me a chart whereby I could evaluate my success in life. I don't recall, now, how it worked—age, I think was plotted along the abscissa and financial return, stipend, emolument or whatever you want to call it was indicated on the ordinates. There may have been other elements but the details really do not matter. With this chart, you could plot a curve showing how successful you were in life.

It seemed like a "swell" idea so straightaway I seized my pencil, looked up my income records and dashed off my curve. The result, let me assure you, was not edifying; something was decidedly haywire. My success curve it seemed was taking some sort of a Stuka nose dive; it looked like the stock market curve on Black Thursday.

Contemplating the dismal result, I cursed my probably well-meaning correspondent in seven different kinds of colored language and finally tore up the graph. Fooey, I said to myself, nuts to him; so he is trying to humiliate me, is he? So I'm a failure, am I? Well, I'll show him.

I Dashed Off My Curve

A Chemist's Appraisal

So I went to a chemist I know and with his help I found the answer I was looking for. In the friendly field of chemistry, I found that my net worth in terms of the value of the chemical elements of which I am composed was 78 cents, or was it 73 cents, it really does not matter. An equally dismal result it may be contended—nothing very inspiring. Perhaps not, but it has this advantage, it is not discriminating. It places me on a par with the most exclusive of the Tycoons. Chemically, a poor, downtrodden wretch of an editor is worth quite as much in the Universe as J. P. Morgan and that, to an editor is something worth knowing.

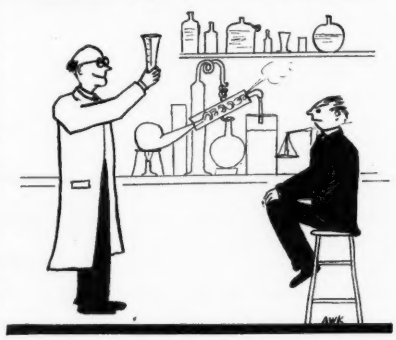
All of which only goes to prove that there is more than one way of looking at a thing. Curves and charts as well as other engineering type of data are all very useful in their place; when applied and interpreted against a proper background of knowledge. In the case referred to, the curve was correct as far as it went but it left out a number of important elements which contribute quite as much to one's success in life as financial return. As Mr. Micawber so aptly pointed out many years ago, a man with an income of $50,000 a year but whose expenses run $51,000 is not necessarily a success financially or otherwise and sooner or later the law of diminishing returns or some other law is going to catch up with him.

I mention these things here because I feel they will appeal to the practical man. The practical man, though he may have due respect for the higher type of technical knowledge, still, has great faith in his intuition about things and in many instances his intuition, like a woman's, is as correct as the processes of so-called scientific method.

Formulas Are OK But So Is Common Sense

My good friend Dan Gutleben of Pennsylvania Sugar told me a story one day about an incident that happened when they were constructing some new coal bunkers. The steel was ordered from a local steel company and while the general drawings were made by the Pennsylvania Sugar engineering department, to expedite the job they employed several draftsmen from the steel company's drafting room to check the drawings.

These draftsmen, however, found some difficulty in understanding the design of the bunkers. As drawn, the plates were arranged in horizontal courses with joints at the columns and stiffened so as to serve as plate girders to carry the bottom. The beams and stiffeners were designed for full load with the usual factor of safety. The Steel Company engineer, however, criticised the plates on the ground that

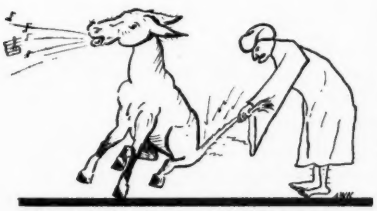


Said I was Worth 78 Cents

they were too thin. He was asked what would happen. The answer was that they would deflect.

"Our reply," said Dan, "was that this obviously, was true but that after the deflection the flat plate formula would no longer hold and the plates would be stronger. However, we added ⅛ in. to the thickness above what we had first intended so as to increase the life against corrosion."

Formulas and engineering data are valuable but like all devices, their application requires knowledge and background. The other evening, at a meeting of the Institute of Radio Engineers, I witnessed a demonstration of the Polygraph—lie detector to most of us. The demonstration was quite successful but as the speaker pointed out, there is no such thing as a lie detector. The polygraph, however, in the hands of a capable person knowing something of psychology and psychiatry, is a valuable device in the detection of deception.



The Hindus Had a Lie Detector

As this speaker pointed out, these so-called lie detectors are not new. The Chinese devised a lie detector long before the polygraph was ever thought of. This was a very simple one. When a person charged with a crime was brought before the examiners he was given a mouthful of rice powder to chew. After a few moments he was told to spit it out. If the powder was still dry the man was judged guilty, but if it was moist he was innocent. The Chinese knew that emotional disturbances affected the secretion of saliva and made use of it in this way.

The Hindus had a more ingenious lie detector. This took the form of a certain ass that was said to bray when his tail was pulled in a dark room by a guilty person. One might be inclined to doubt this but the fact that they carefully dusted the ass's tail with lampblack before the test proved that the Hindus were better psychologists than they were inventors. The innocent person, of course, had no fear of the test and did not hesitate to give the tail a yank but the guilty victim, knowing that his action could not be seen in the dark, carefully avoided touching the tail. Paradoxically, his clean hands proved his guilt. Keen practical knowledge of human nature made this kind of a lie detector highly effective.

It is the importance of this background of knowledge that is often the practical engineer's greatest asset. It often enables him to see at a glance what it takes a technical expert with a slide rule and a factor of safety an hour to work out. This, of course, is not always true; the technical expert also has his peculiar merits and there is no intention here of detracting from his place in the sun. He also serves who wields a slipstick.

So much for that. Somehow or other I entirely got away from what I started to talk about, which was "maintenance", not the kind of maintenance that concerns the operation of a stoker or a pump but your own maintenance. It may seem rather silly to waste much time maintaining something that has an intrinsic value of only 78 cents but in this case as in others, it probably is not the value so much as the principle of the thing.

Mens Sana In Corpore Sano

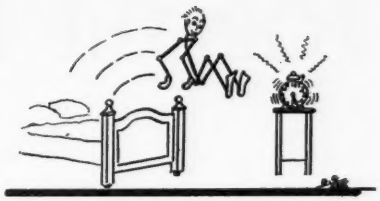
One of the things that has continued to intrigue visitors to Dan Gutleben's office at the Pennsylvania Sugar Refinery in Philadelphia is his famous exercise chart. Ever since I first started to write about Dan Gutleben's work in these pages, various individuals who have seen this chart have been urging me to publish it. Homer Rank of the Strong Scott Company in Minneapolis, once sent me a special telegram urging its immediate publication. Well, it is somewhat away from strict engineering but here it is—— on page 84 in place of the usual technical chart.

It looks like a page from Sherlock Holmes' Mystery of the Dancing Men but really it is an engineer's—a very good engineer's—idea of how to keep fit. We have his word for it (and this is all we need) that he, himself, follows it every morning. Frankly, I have never had what it takes to go through anything like this as a regular habit but there may be some among you who read this that have this courage and the fortitude to do it. More power to you, if you have. I have never hesitated to urge others to take these exercises regularly.

Admiral Grayson, the one time physician at the White House, once specified the five essentials to good health, to wit: System, Diet, Exercise, Sleep, and Sense of Humor.

With respect to the second, a well-known dietitian asserts that the greatest bar to longevity is the abuse of the digestive apparatus. So diet is of importance.

"The average man, however," says Dan, "is not of so much value as to make his longevity of importance. Modern tools permit him to cover a far greater territory than could have fallen to the lot of an entire regiment of his mythologically long-lived ancestors. It *is* important, however, that while he lives he be vigorous and free from ills so as to escape being a burden to himself and his fellows. A querulous old man is one who has neglected proper mechanical and mental maintenance. By analogy, a boiler cannot perform effectively without the right quantity and quality of fuel and without systematic removal of clinkers, and it must have plenty of pure water.



The Beginning of Practical Maintenance

"After the 'power plant' there follows next in importance the maintenance of the structural equipment. Use avoids atrophy. The average engineer does not need to strive for outstanding physical development, but he should maintain an efficient working machine. He should not emulate the neglected machine that uselessly occupies valuable space and delivers no profit.

"The chart on page 84 illustrates maintenance exercises selected mostly from the Military Manual. They start modestly with hand exercises, then follow with movements of the arms and shoulders as well as trunk, and end with a combination of all. All of the movements after those of the arms are accompanied by heavy breathing. When this schedule has progressed into a daily habit, it requires 15 min. of time. It is desirable to perform in the nude before an open window—Winter and Summer. To install a regular systematic drill into a daily routine requires discipline, which is to the will what the contortions are to the muscles. When the schedule has developed into an unfailing habit like the morning shave, the will performs as gracefully as the muscles respond."

"Every Man Owes It to His House To Keep Fit"

Taking these exercises may not be as glamorous or as soul-satisfying as tuna fishing or duck shooting (see P. Pete's letter, page 82) which some people indulge in for sport or exercise but it has the advantage of being cheap and available to everybody even to engineers who have to work at their jobs eight to sixteen hours a day. All it requires is a proper outlook on life, some fortitude and a constitution worth while maintaining. If you have these, we have Mr. Gutleben's word for it, the rest is easy.

Well, there it is. It may seem a strange sort of subject to discuss in the pages of an engineering journal but it is probably quite as useful as many other things which appear under the guise of engineering data and if it is of sufficient importance to form part of the Pennsylvania Sugar Company's "Engineering Log" it seems that it is important enough to present here.

A. W. Kramer

FOR THE PLANT ELECTRICIAN

Maintenance and Installation of Fluorescent Lamps

By MERRILL A. RADAMAKER

THE RAPID INCREASE in the use of fluorescent lamps in industry imposes still another duty to the many already carried by engineers and electricians in industrial plants. Since the high efficiency and high quality of illumination furnished by these lamps are such that their use is certain to be extended, it behooves us to learn something about the installation of these lamps. They are fast surpassing older lighting systems.

While the two most popular tubes are the white tube and the daylight tube, there are colored tubes which produce direct colored light, caused by different chemicals. These methods of producing colored light are far superior to the old methods using colored glass or reflected light. Numerous color schemes can be worked out with the present available color-producing chemicals, calcium tungstate for blue, magnesium tungstate for blue-white, cadmium silicate for yellow-pink, and cadmium borate for pink. It is interesting to note that the three standard tubes, gold, daylight or white tubes can be installed in the same fixture to produce an artificial sunlight. The standard tubes now on the market are obtainable in seven different colors: daylight, white, gold, blue, green, red and pink. These tubes may be obtained in the following convenient sizes: (15 watt, 18 in. x 1 in. and 18 in. x 1½ in.), (20 watts, 24 in. x 1½ in.), (30 watts, 36 in. x 1½ in.), and (40 watts, 48 in. by 1½ in.).

In renewing or inserting these tubes in their sockets they should be grasped firmly with both hands near the ends of the tube, gently feeling your way into the contacts of the lamp sockets and at the same time being careful not to bend the prongs on the ends of the tube or the contacts inside the lamp socket.

When placing the starter type switch in position it should be pressed down and given a quarter turn to the right in the same manner you would place an automobile lamp in its socket. To remove push down and turn to the left. Always keep a supply of the starter switches and tubes in stock. The types and sizes will depend upon the type and size of fixtures you are using in the fluorescent system.

Fluorescent lights are usually operated on alternating current, 115 volts, 60 cycles. It is possible and practicable to operate these on 50 cycles, and auxiliaries are available for this frequency. The lamp itself will operate on 25 cycle, but on this frequency the flicker is pronounced. However, fluorescent powder, except for the blue fluorescing variety, has the persistency of glow or phosphorescence which helps to reduce the flicker.

With lamps burned on two or more phases or with a two-lamp transformer the lamps operate out of phase and the fluctuation in the light output is further reduced and becomes comparable to the variation in low wattage filament lamps.

Fluorescent lamps are designed for alternating current but it is possible to operate them on direct current. The same inductive coil is used to provide the inductive kick necessary to start the lamp, but it will not provide the required current ballast. A resistor can be placed in series with the choke coil. Care must be taken to use the proper size in order to prevent overheating. A lower efficiency is encountered on a d.c. supply than on a.c., making the former inadvisable except in emergency.

The characteristic transformer hum is noticeable at times and can be dampened out by the use of rubber mountings on all inductive coils in the fixture. All fluorescent lamps have a low power factor and should be supplied with a condenser by the manufacturer of the fixture unit.

It is possible at times to reactivate a light tube when it is not fluorescing properly by removing it from the sockets, shaking it vigorously in a horizontal direction.

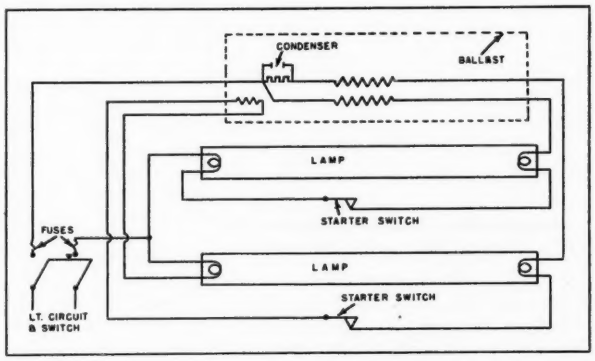


Fig. 2. A typical double lamp wiring diagram for fifteen and twenty watt 110 v. 60 cycle lamps showing starting compensator and condenser

When maximum light efficiency is needed for close work it is advisable to supply the engineer or electrician with a light meter equipped with the proper filter as the old type light meter is not correct for this type of lamp.

Blackening at the ends of the tubes will be noticeable in the first 100 hr. of service, but this will not increase during the remaining life of the tube, which is about 2000 hr. If one lamp does not burn in the fixture, test by replacing with one that does. If this does not succeed in lighting, it is likely that a new starting switch is needed or that a loose connection in, or running to the socket is the cause of trouble. The last place to look for trouble would be in the auxiliary device located in the fixture enclosure. This auxiliary device consists of choke-coils and condensers. Some fixtures are equipped with a magnetic type starter switch instead of the smaller and more convenient thermal starting switch. The thermal starting switch consists of a bimetallic strip and heater coil sealed in a small evacuated glass bulb, and operating on the principle of the common socket flasher.

In connecting these fixtures to electric outlets it is more convenient to use the new type wire connectors after soldering than it is to use rubber and

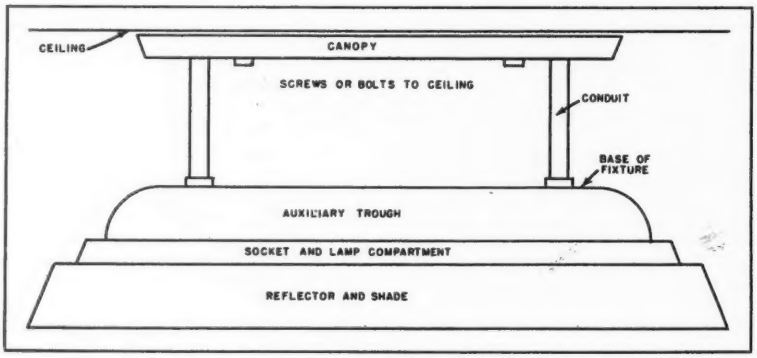


Fig. 1. Fluorescent Fixture Suspended from Ceiling

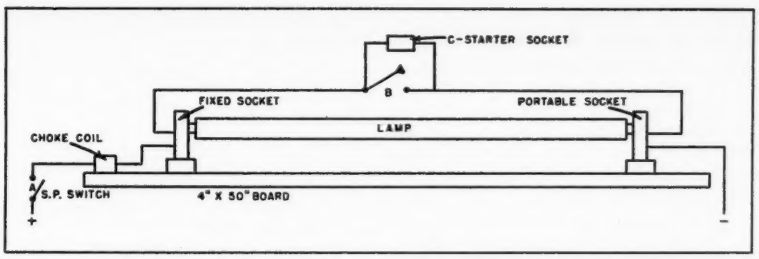


Fig. 3. Arrangement used for testing fluorescent tubes

friction tape. To use these new type wire connectors it is possible to use the fixture or pigtail splice only. They can be twisted on or off of the splice which is an advantage when the circuit is to be tested for trouble.

Figure 1 gives an example for suspending a fluorescent fixture from a ceiling where outlets on the ceiling are located at the center of the fixture. The canopy covers exposed wires leading down through the conduit to the auxiliary trough. The fixture chain can be used with the regular fixture wire instead of the conduit extension if preferable. If it is possible to mount the base of the fixture flush with the ceiling it will improve appearances.

The auxiliary trough is used for inclosing the induction coils, condensers and wiring for lamp sockets. The lamp compartment and shade are detachable in large fixtures, from the auxiliary trough, for the convenience of installation and maintenance. This type fixture can be designed to accommodate as many lamps as desired.

The diagram in Fig. 2 shows a typical double lamp wiring plan for fifteen and twenty watt, 110 and 125 volt, 60 cycle lamps, including integral starting compensator and condenser for a high power factor.

A method is diagrammed in Fig. 3 for testing tubes, of different lengths, and starting switches. The first step is to close switch B, and then close switch A. Third, open switch B. When switch B is opened, the induction action of the choke coil produces the voltage kick necessary to cause the arc to strike. If the lamp is in good condition it will glow.

For testing the thermal starting switch place a good lamp in the sockets and open switches A and B, insert the thermal switch in the thermal switch socket C and close switch A, leaving switch B open. If the thermal starting switch is good the lamp will glow.

Proper Care and Maintenance of Electrical Instruments

THE FOLLOWING NOTES on the proper care and maintenance of electrical instruments were prepared by H. H. Dawes for the General Radio Experimenter. They were intended specifically to cover the care and maintenance of instruments used in delicate measurement work but they apply equally well to instruments in general.

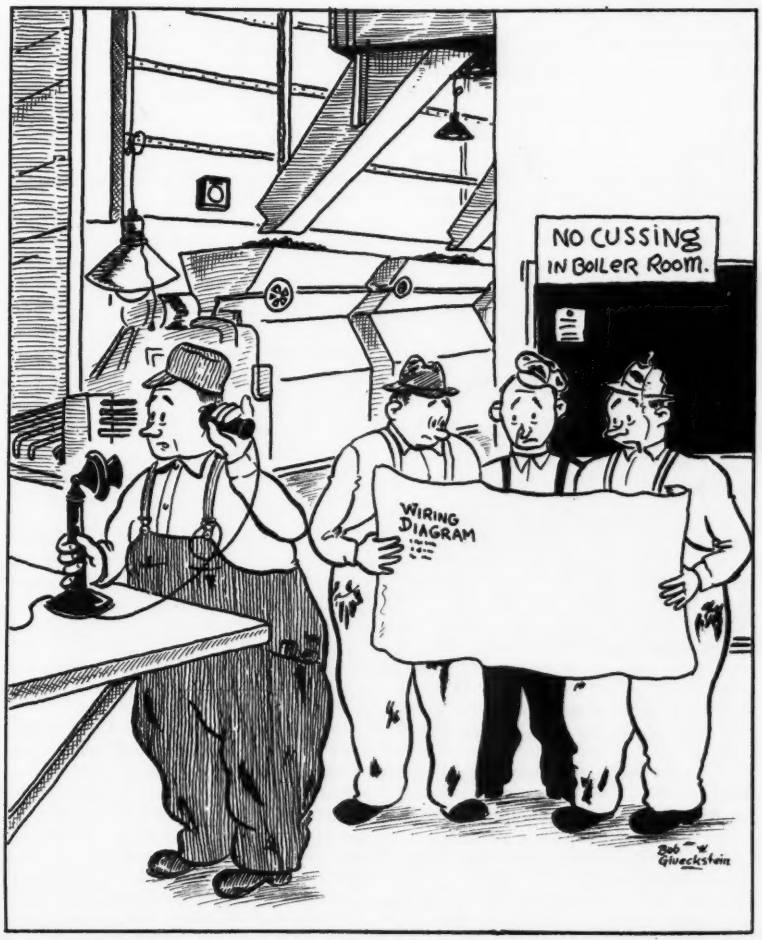
With instruments as with all other things, it is desirable to follow a definite maintenance program. The fine degree of accuracy of many instruments is dependent in part upon the smooth operation of controls free from backlash, clean contacts, and the exclusion of dust and foreign matter.

It has been found that a large part of the charge made for reconditioning instruments is for the labor of replacing parts that have not been properly cared for, cleaning contacts, lubricating moving parts and removing foreign matter such as dust, grit, insects, bits of metal, salts from corrosion and the like. Much of the inconvenience and expense of returning instruments to the manufacturer for repair can be avoided if the user follows a program of periodic inspection and adjustment in his own test department or laboratory.

Of course in many applications operating conditions are such that wear and corrosion are inevitable, but a definite maintenance program will help to minimize deterioration and failures.

Equipment used for production testing demands frequent servicing. An instrument operated occasionally may have to be serviced each time used because of oxidation of contacts, switches, etc., presence of foreign matter, and possible moisture. Lack of lubrication and the presence of foreign matter on switches, contacts, bearings, controls, and mechanisms cause considerable difficulty even when an instrument is relatively new.

Instruments should be kept as clean as possible. A solution of half alcohol and half ether is recommended for switch and relay contacts, contact surfaces of wire-wound controls, slide wires, and mechanical contact surfaces of various types such as mouse-trap



"Morning Bugle? Let me speak to the Puzzle Editor, Please!"

type attenuators, detent mechanisms, chain drives, gear trains, shafts, and bushings. To remove oxidation or corrosion, a fine abrasive such as crocus cloth may be used, but its use is limited to relatively large contact surfaces such as those on Variacs, attenuators, and relay contacts.

A very fine grade of sandpaper is recommended on certain types of contacts, although the residue must be removed with a fine brush for smooth operation. Fine sandpaper may be used on wire-wound controls, key switches, push switches, anti-capacity type switches, and multi-blade-contact rotary switches; also on contact buttons and relays.

Some assemblies, such as syncro-clocks, piezo-electric crystals, motors, and meters require special attention. Syncro-clocks should be carefully cleaned by one acquainted with fine mechanisms of this type. Quartz crystals should be returned to the factory. Electric motors demand the usual attention to commutator surfaces, brushes, and bearings. Meters should not be cleaned except by one skilled in handling such fine work.

Proper lubrication is very important in the maintenance of precision instruments. Some bearing surfaces require a grease, while for others oil is best. When instruments are assembled at the factory, moving parts are lubricated with either "Lubriko,"* or a fine grade of clock oil, and the use of these lubricants is recommended in maintenance.

Lubriko has been selected because it is acid free and because it adheres to moving parts better than most lubricants. It is recommended for use on wire-wound controls, button contacts, attenuators. However, a very thin film should be applied, as a large quantity will cause foreign matter to collect.

For detent mechanisms, chain drives and gear trains, ball bearings, shafts, vernier drives, etc., a larger amount should be used. These moving parts require lubrication more frequently to prevent wear.

The use of a fine grade clock oil is recommended for slide wires, push-button switches, syncro-clocks, and condenser bearings. This type of lubricant should be applied in very small quantities. A thin film applied with the finger will suffice for a slide wire but this should be done frequently because of evaporation. The small gear on the shaft of the rotor of a syncro-clock requires lubrication every few months.

It is always well to inspect the wiring in an instrument. While every effort is made during manufacture to solder firmly each connection, occasionally one will break loose due to excessive vibration either in transit or in use.

Dials are lacquered and usually do not require much attention. However, the use of an oil polish will improve their appearance. For smooth operation slow-motion drives, either friction- or gear-type, must be cleaned occasionally. A fine brush and a cloth saturated with carbon tetra-chloride are satisfactory.

An oil polish may be used on wood cabinets, panels, and dust covers to improve appearance. The crackle finish can be restored to its original appearance by using an oil polish and carefully wiping afterward.

For specific instruments, these general suggestions often must be supplemented by more specific information, usually included in instruction books.

*Density MD, manufactured by Master Lubricants Co., Philadelphia, Pa.

REFRIGERATING PRACTICE

An Automatic Tube Ice Machine

THE DEMAND for "sized" ice is increasing daily. Many milk plants, fisheries, packing plants, chemical plants, etc., are using ice "sized" to their particular requirements. In order to meet present demands and to develop new and profitable uses, "sized" ice must be produced with a minimum of plant investment, power and labor. It must also be of such shape, quality and appearance as to be suitable for many uses.

As reported in Refrigerating Engineering, the Vogt automatic tube-ice machine offers an interesting method of producing the required product.

Ice of relatively small dimensions, cylindrical in form and either hollow or solid, is frozen quickly in the self-contained tube-ice machine. It employs a cycle in which freezing and thawing alternate, each being produced by successively applying the liquid refrigerant and the warm refrigerant gas to the tube surfaces in the freezing unit.

Direct application of the refrigerant eliminates all costs incidental to brine systems and permits higher evaporating pressures with resultant economy in power.

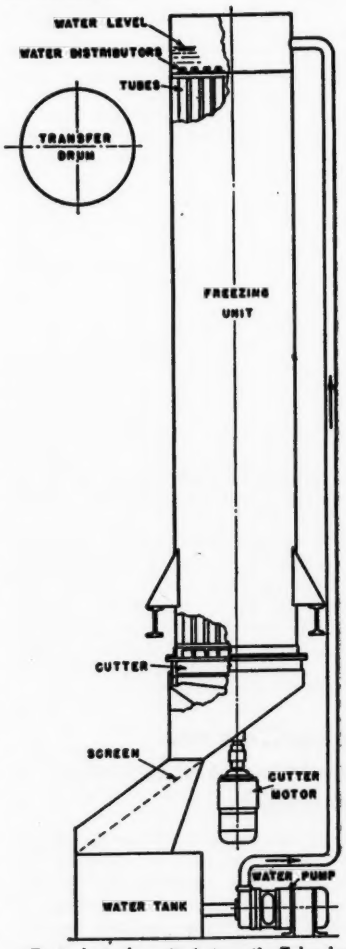
The tube-ice machine consists of one or more vertical tubular shells, an accumulator, piping, valves and automatic controls.

Water is pumped to the top of each shell and flows downward along the inside walls of the tubes and into a water tank below. The refrigerant is admitted into the shell and surrounds the tubes, thereby freezing the water and producing cylinders of ice in the tubes. A timing mechanism, operating through suitable valves, automatically controls the functions of the machine whereby the cycle of operations may be adjusted from time to time to produce either hollow or solid cylinders as desired.

To free the ice from the tubes the refrigerant is removed from the shell by the admittance of high pressure, warm gas from the condenser which causes a slight melting at the tube surface. Water also is admitted beneath the lower tube sheet as an aid to thawing and is recirculated and frozen in the following cycle.

In this system nothing leaves the apparatus but the ice produced. There is no waste thawing water discharged to the sewer. The thawing water in melting the ice (on the lower tube head only) is itself reduced in temperature, and enters the system, and eventually becomes ice. The thawing water is taken from the same source as the make-up water. In the thawing operation some of the refrigerant gas is undoubtedly liquefied in the freezing vessel, so that thawing constitutes merely the transfer of heat from one part of the system to another.

The washing process—a result of the water circulating system employed—produces clear tasteless ice, of the same quality and appearance as can ice, and is equally suitable for direct immersion in beverages.

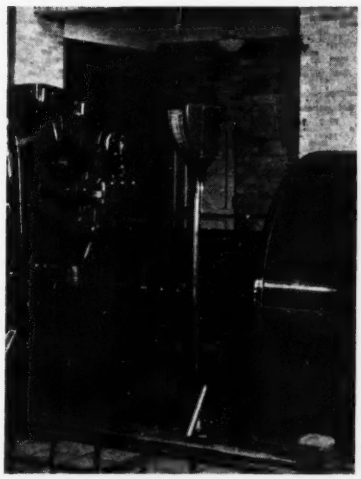


Typical single unit Automatic Tube Ice Machine

SHOP TALK

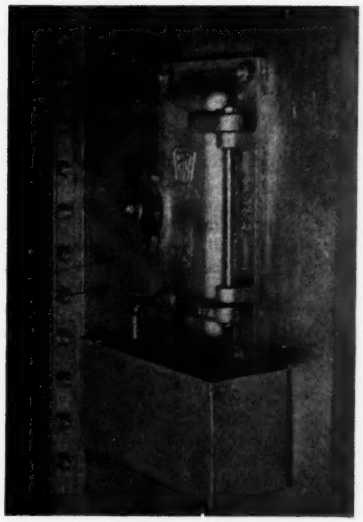
A new department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.

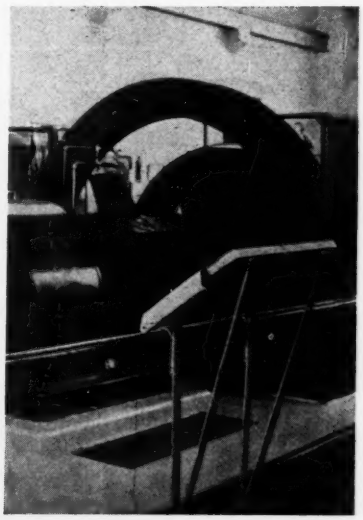
STARTING TACHOMETER—At low speeds during the starting period, the usual turbine tachometer is of no use. The new 825 lb. turbine at Riverside Station, United Power Mfg. Co., must be run for one hour at 600 r.p.m. while warming up. To give an indication of the speed during this period, H. A. Kleinman, engineer, designed this tachometer made from two conventional Bailey draft gages mounted on a convenient pedestal. The scales are carefully calibrated from the differential pressure created by the generator cooling fan, although tests showed that the speed and pressure characteristics slowly approach a square root curve. The first scale or gage measures the differential up to 1 in. for speeds of from 0 to 1000 r.p.m. The second scale or gage runs from 0 to 4000 r.p.m. The maximum differential is between 10 and 11 in. of water. This generating unit is unique in that it has five generators, a 25,000 kw., 13,000 v. a.c. main generator, a 2500 kw. a.c. house generator, and three 250 v. exciters, one 100 kw., one 25 and one 4 kw. The turbine is designed to carry full load on either 825 lb. steam using four valves or on 400 lb. steam, from the older boilers, using nine valves.



INSTRUMENT PANEL—When Harry Atchley, chief engineer of the Crystal Tissue Co., Middleton, O., remodeled his boiler room last year he made this panel for mounting his instruments, using angle irons for support and a ¼ in. steel plate enameled black for the panel. All pipe and wiring come in from the bottom at the back. The door opens up so as to give ready access to the back.

GOOD HOUSEKEEPING—Cleanliness is always an indication of good operation and when the entire boiler room is painted aluminum as is the New Castle (Pa.) Station of the Pennsylvania Power Co., no source of dirt and dust can be overlooked. Observation doors on boilers are necessary but some dust siftings cannot be avoided every time they are opened. To prevent this, each door is fitted with a small box as shown. This catches the dust but does not interfere with opening the door or the view of the furnace. Oil burners, used as igniters in the pulverized coal burners, also have a bib as shown at the above. It is made in the shape of an arc with a wide lip on all four edges and slides in and out on angle irons, bolted to the burner front. J. W. Mikels is station superintendent and J. C. Duff is Efficiency Engineer.





LOG HOLDER—Finding a permanent and convenient location for copying instrument readings in the log is not always easy. B. H. Whitehouse solved this problem in the Milwaukee Country House of Correction plant by means of this device welded up from strap iron. It locks over the guard rail at any convenient point. Padding of cloth or rubber can be added to prevent scratching the paint. The log sheet is thumbtacked to a board which can be slid out of the pocket formed light sheet iron bent slightly at the edges.

Questions And Answers

An S. O. S. from the Philippines

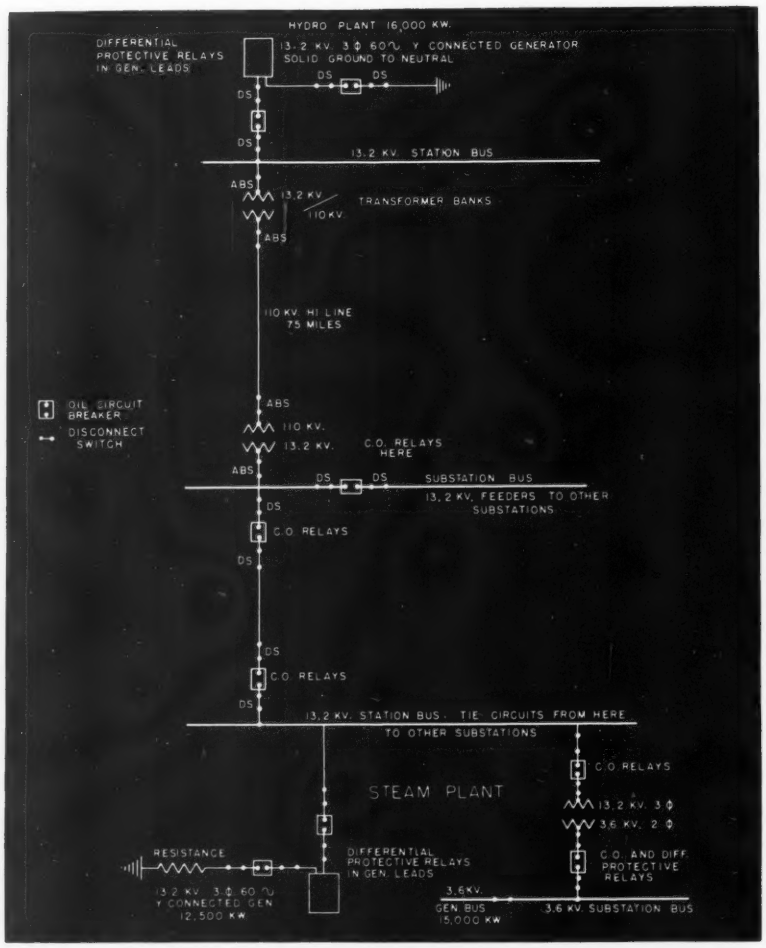
Q. I would appreciate comments and suggestions by other readers on the electrical problem indicated below.

In the accompanying diagram is shown the single line connections of our electrical system. As may be seen, the only protection for the 13.2 kv. generators are the differential protective relays in the generator leads. The oil circuit breakers in the grounded neutrals of the generators in both the hydro and steam plants are manually operated.

Normal operation is with the setup as shown. In times past when a heavy ground has occurred on a 13.2 kv. circuit, it has resulted in the resistance of the steam driven generator being burned up before the operator could open the oil circuit breaker.

Comments or suggestions are requested as to the best procedure for operation and as to arrangement of relays.

Manila, P. I. F. T. Lauriat.


HYDRO PLANT 16,000 KW.
DIFFERENTIAL PROTECTIVE RELAYS IN GEN. LEADS
13.2 KV. 3 Φ 60 ~ Y CONNECTED GENERATOR SOLID GROUND TO NEUTRAL
DS
13.2 KV. STATION BUS
ABS
13.2 KV.
110 KV.
TRANSFORMER BANKS
110 KV. HI LINE 75 MILES
OIL CIRCUIT BREAKER
DISCONNECT SWITCH
110 KV.
13.2 KV.
C.O. RELAYS HERE
SUBSTATION BUS
13.2 KV. FEEDERS TO OTHER SUBSTATIONS
C.O. RELAYS
13.2 KV. STATION BUS - TIE CIRCUITS FROM HERE TO OTHER SUBSTATIONS
STEAM PLANT
RESISTANCE
13.2 KV. 3 Φ 60 ~ Y CONNECTED GEN 12,500 KW
DIFFERENTIAL PROTECTIVE RELAYS IN GEN. LEADS
3.6 KV. GEN. BUS 15,000 KW
13.2 KV. 3 Φ
3.6 KV. 2 Φ
C.O. AND DIFF. PROTECTIVE RELAYS
3.6 KV. SUBSTATION BUS

How Are Compressors Operated in Parallel?

Q. Please explain the proper way of operating two single stage compressors. How should they cut in to take load and is there any danger of one working full load continually and the other cutting in and out? The engineer in charge of the plant claims that both compressors cannot be operated at the same time unless the unloaders are all hooked together so both machines cut in and out together.

Detroit, Mich. M. B.

Refrigerating Engineers, Please Note

Q. I would like to know what methods are used to test for moisture in ammonia and where in the compression system the test should be made? What methods are employed to remove moisture? Is there any manufacturer that specializes in this problem?

Detroit, Mich. H. T.

What Is Plugging?

Q. What is meant by the term "plugging" in motor operation?

Berwyn, Ill. F. Moran.

A. Plugging consists in connecting a motor to the line in reverse direction while it is still rotating in the forward direction. In stopping a motor it is often desirable to reverse the power connection and so bring the motor to rest quickly by its tendency to run in the reverse direction. This is plugging. However, if the motor is to stop, it is necessary that the plugging power be removed at the right moment to keep the motor from re-accelerating in the reverse direction. This is best accomplished automatically by a plugging switch.

In one type of plugging switch on the market a driven Alnico rotor produces a rotating magnetic field which induces eddy currents in the walls of an aluminum cup which surrounds it. The magnetic reaction produced by the eddy currents turns the cup through its limited rotation and contacts are operated by an insulating rod which connects the cup and a movable contact strip. Centering springs tend to keep the contacts in the normal position but since the magnetic operating force on the aluminum cup is dependent on speed, the contacts operate at and above a definite speed. Since the Alnico rotor is driven by the motor shaft, as the speed decreases, a definite point will be reached where the spring force will overcome the magnetic force. At this point the contacts trip and the plugging circuit is opened.

In plugging care must be taken to introduce proper resistance into the circuit to prevent overload. When a motor is plugged the countervoltage of the armature is in the same direction as the

line voltage instead of opposing it. Consequently, nearly double voltage is applied across the series resistance and it becomes necessary to use additional resistance in order to limit the inrush current under plugging conditions.

Calculating Float Size

Q. Can you give me information on how to calculate the sizes of wooden floats to be used in the operation of float switches?

Milwaukee, Wis. P. C. Z.

A. Several fundamentals must be kept in mind in the development of a float. The power required to operate a switch is provided by the water displaced above and below the normal draft of the float. Thus the greater the area of the float the less required depth and the result is greater sensitivity. 1.75 cu. in. of water weighs 1 ounce so that if the switch requires a pull of 10 ounces, 17.5 cu. in. of water must be displaced to actuate it. Thus a float 10 inches square will sink 0.625 inches which proves that a float should weigh near the limit of the breaking strength of the chain and be equipped with a counter weight weighing half the weight of the float and which pulls it half out of the water.

Such a balanced arrangement provides equal weights for properly actuating the switch mechanism. Where a rod replaces the chain the float functions best when half submerged.

The above calculations are based on the use of dry wood. To prevent a wood becoming waterlogged and out of balance it is recommended that it be immersed for 15 minutes in paraffin 200 deg. F.

A Mechanical Version of Lincoln's Famous Question

Q. What is the proper length for a side rod on a Corliss engine governor?

Brookline, Mass. J. J. H.

A. It seems to us that this question is analogous to Mr. Lincoln's famous question, "How long should a man's legs be?" Your question can be answered quite as simply as Mr. Lincoln's by stating that the rod should be long enough to move the bell crank equal distances on each side of the horizontal when the governor is moved from one extreme position to another.

How Can Boiler Scale Be Removed?

Q. I have a problem involving the removal of boiler scale on which I would appreciate the advice of other subscribers. We have a small return tubular boiler which has scaled up quite badly. An analysis of the scale discloses the following composition:

Iron ($Fe_2 O_3$) 7.89 per cent.

Calcium Carbonate ($Ca CO_3$) 74.03 per cent.

Magnesium Carbonate ($Mg CO_3$) 13.23 per cent.

Silica ($Si O_2$) 3.30 per cent.

I would like to know whether there is a method available involving some chemical for quickly boiling out this scale? All comments will be appreciated.

Middletown, Ohio. Boyd Standofer.

WHO'S GOT THE MISSING LINK?

ON PAGE 55 of the November issue, we presented a short description of George Hawkins' fuse collection which, as may be recalled, he had mounted on the front of a giant size robot—"Old Man Fuse," we called him. Well, now Mr. Hawkins needs your help. He needs another fuse and the chances are that if you have an old junk box where the odds and ends of many years are gathered, you may be able to help him out. We present his letter as follows:

"As an electrician and reader of Power Plant Engineering, I wonder if some reader could help me out. For over 25 yr. I have collected old types of electric fuses and as described in the November issue of Power Plant Engineering, have over 200 different makes in my collection. There is a missing link in this collection, however, which I have been trying to find for months. This is an old type link fuse. There probably are some of these link fuses still to be had but it is difficult to know just where to look for them. They are usually mounted on old types of electrical machinery or panel boards. It is possible that some reader of Power Plant Engineering has one of these old link fuses lying about or mounted on some old piece of electrical equipment not in use any more. If some reader has one of these old link fuses that he has no further use for I will sure appreciate having him mail it to me for my collection."

GEORGE E. HAWKINS
2999 Fulton St.
Brooklyn, N. Y.

Pressures and Temperatures for CO_2 System

A. In the November issue in the Questions and Answers Section, A. T. K. wants to know about the correct suction pressure and A. G. Solomon answers the question.

While Mr. Solomon's comments are well put, I feel that there are many other factors to be considered. First, if a carbon dioxide compressor does not compress the proper amount of gas at each stroke, the pressure on both gages are fictitious. In investigating this matter the system must contain the proper amount of refrigerant, in this case CO_2.

If there is sufficient CO_2 in the system the difference in the condensing water will be about 10 deg. F., assuming the condenser is fairly clean.

The proper suction pressure, if the system is charged to capacity and kept near the critical pressure will be about 23 atmospheres.

Several years ago when I was in charge of a similar plant I put the fan motor into reverse and exhausted all the stagnant air so that when the people started to come in the theatre, air was clean and fresh. As a matter of fact I exhausted the odorous air several times during a performance.

In taking care of compressors one should never use filtered oil for the crankcase; doing so will only result in scored piston rings.

Leaks in a condenser can sometimes be detected by using thymol blue which turns yellow when carbon dioxide is present in the condensing water.

All these points are of the utmost importance and I feel they should be added to what Mr. Solomon has said.

New York, N. Y. Carl Egerter.

Three Phase Motor on Single Phase Current

Q. Is it possible for a three phase motor to start if one of the three fuses is blown?

Boston, Mass. R. F.

A. With one fuse blown, the motor will be supplied only with single phase current and under such conditions a three phase induction motor will not start. The motor could be started by hand or other means, and would come up to speed but under such conditions would carry only about 40 per cent of its rated load.

How Would You Do It?

Poor hot service water circulation and sputtering faucets put Our Hero on the mat in the manager's office. He suspected the piping system and is happy to report his own successful solution together with many other suggestions submitted in the contest outlined in November.

PROBLEM 13

Hot Water Service

WHEN the manager said something had to be done immediately to correct the poor hot water circulation and sputtering faucets in the apartment building where Our Hero works, an appeal was made to readers of the Practical Engineer and Electrician in the November issue. Quick action, however, was required so Our Hero did what he considered an expedient and perhaps temporary thing pending replies from the contest. No, he is not in the contest, that would be extremely unfair, but his solution has worked so satisfactorily that he thinks contestants

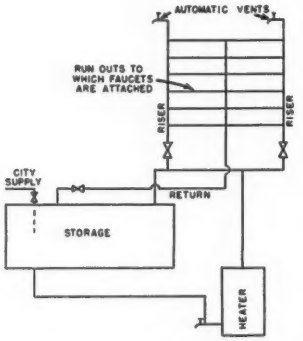


Fig. 1. Diagram of unsatisfactory hot water service piping

will be interested in it as well as many of those presented for consideration.

Referring to Fig. 1, which is a diagram of the piping as he found it, his correction consisted in running the return and riser connections down into the storage tank 1 in. beyond the shell, then attaching an automatic air vent at the top of the storage tank. This change has stopped complaints, improved circulation, eliminated air in service faucets and the expense was very little.

Our Hero was on the job and had to do something quick with the equipment available which gave him no chance to design a new system and he is not sure that his system could not be improved so he is making a study of each and every solution presented in the contest for he knows that every one of them has some feature of merit.

Strange as it may seem, among the dozens of suggestions submitted there were no two exactly alike and your judges have found it extremely difficult to arrive at a rating. Close examination, however, has enabled them to pick the three winning suggestions and they are presented here in full. So interesting, nevertheless, were many of the other suggested solutions that a number of them have been briefed or submitted only in diagram for what benefit they may be to readers.

First Prize Award

H. P. Storer
Pawtucket, R. I.

IN PRESENTING a solution for this problem it is evident that two problems are involved:

1. The presence of air in the water.
2. The lack of sufficient quantity of hot water.

It is assumed that heater, storage tank capacity and pipe sizes of risers, run outs and other connected piping are adequate.

The presence of air in the water must be due to an excessive air content in the city supply, and in the present system, any air in the storage tank must ascend in the risers and return piping, some of which would be vented by the automatic air vents at the riser terminals, but as there is no vent in the return riser, it is apparent that any air in the return riser would be trapped until water was drawn from a faucet, then owing to the lowered pressure in the run out, the trapped air in the return would be liberated at the faucet, causing splashing. The pressure of air in the return piping would act as a circulation block, and since air would be admitted to the system as long as hot water was used, circulation could not be established.

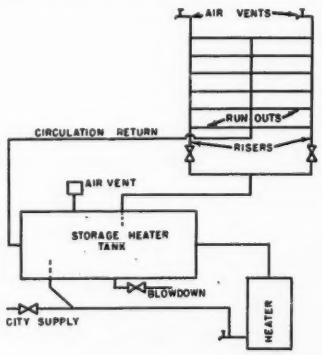


Fig. 2. Recommended by H. P. Storer

Solution No. 1: As will be noted on enclosed sketch the hot water supply line comes from the top of the storage tank. This outlet is extended 6 in. down into the tank from the top. Any air in the water of the tank will rise above the point of hot water discharged preventing air reaching the risers. From a point at the top of the tank, a small line is piped to float type air vent, in order to eliminate air as it accumulates. It will be noted also that the hot water supply line from the tank is extended to a point midway between the risers. This is important as it prevents the nearest riser "hogging" hot water. The circulating return riser is carried to one end of the storage tank at a point below its center, to prevent air reaching the return piping and to accelerate circulation.

In the present lay out, city water is admitted to the top of the storage tank through a pipe extending about half way into the tank. As hot water is used the city water enters the storage tank, agitating and reducing the temperature of the water already heated, the action also agitates impurities that have settled out at the bottom of the storage tank. This impure water is forced through the heater when some of the impurities settle out causing the heater to foul. The hot water riser from the heater connects the main risers then drops to the storage tank, since any air liberated by water at the heater can reach the risers, this design is objectionable, the drop to the storage tank of the circulation line from the heater top imposes restriction which can be avoided.

Solution No. 2: Extend city supply to bottom of heater and in this line place a Y pointing in the direction of the heater, into the Y, pipe the circulating line from the bottom of the storage tank. At the storage tank end of the lower circulating line, place an extension 6 in. above the bottom of the tank leaving a sediment pocket. Install a drain from the bottom of the storage tank to the sewer for sediment removal. Pipe the circulating line from the heater to the storage tank at mid point on the tank and opposite that of the lower circulating line. The horizontal run of this line to the tank should be increased

4 times the area of its connecting riser from the heater, to minimize turbulence of hot water in storage tank.

The above design of the circulation lines from and to the heater insures the maximum circulation and heat transfer. The city supply is piped to heater so that the heating coils will always come into contact with the cleanest water, and in piping the lower circulating line from the storage heater into this line, a Y is used to set up a siphoning effect which accelerates circulation whenever hot water is used, and also causes a slight rise in temperature of city water before it enters the heater.

The above design I have applied to a somewhat similar hot water heating system, which was sluggish. The change almost doubled the former hot water output.

Second Prize Award

William H. Grover
Maumee, Ohio

IN YOUR apartment house you have a hot water service as illustrated in Fig. 3 on accompanying sketch.

This hot water service is somewhat out of the ordinary. It is equipped with two supply risers taking off of the top side of the storage tank and returning through the common return to the top of the same tank. Also it will be noticed that the city supply delivers the raw cold water to the top of the tank. Then the heater is connected in the ordinary way so that the discharge from the heater may go to the faucets, if required, or it may flow to the storage and ultimately to the heater.

The intention of all such hook-ups is for the water to make a complete circuit, in both of the rises, so that hot water may be had instantaneously at any of the lavatories, and of course it is intended that the storage is to take up the slack. That is, if no water is being used at the lavatories, the circulation will continue and the hot water will accumulate in the upper part of the storage.

In the matter of making an analysis of the circulation of the hot water, we have two principles to depend upon. First, the total altitude of the services,

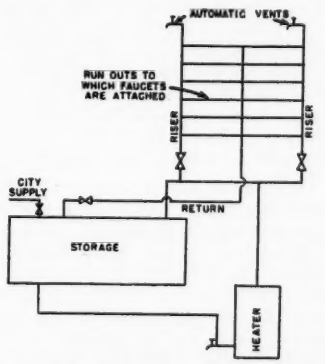


Fig. 3. Problem diagram as reproduced by W. H. Grover

PROBLEM No. 14

PUMP WILL NOT START

Our hero recently sold the "Old Man" on the idea of buying a badly needed service water pump. Since the power factor was low, he decided to kill two birds with one stone and so installed a centrifugal pump driven by a synchronous motor. Everything was swell until it was time to start the unit and then it would not start. The motor would bring the pump up to speed if it was empty but not when it was primed. This type of pump is peculiar in that it will not take water once it is up to speed unless there is sufficient head on the intake side to force the water into the rotating impeller. According to data furnished by the motor manufacturer the pull-in torque of the synchronous motor is ample to start the pump under load, yet it will not do so. The motor is an ordinary synchronous motor with a damper winding. Our hero has not had much experience with this sort of thing so he wants advice. If you had this installation and these facts were brought to your attention where would you start looking for trouble and what do you think might be wrong?

Write out your opinion in a letter of not over 1000 words and send it in to the Contest Editor by January 25. A first prize of $15 will be awarded for the best letter, a second prize of $10 and a third of $5. Entries should be addressed to the Contest Editor, Technical Publishing Co., 53 West Jackson Blvd., Chicago, Ill.

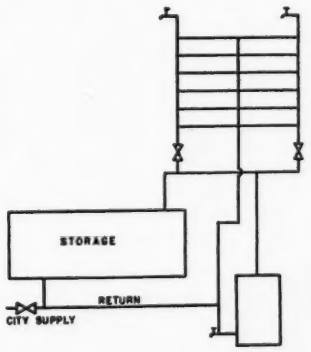


Fig. 4. W. H. Grover suggests this piping to correct difficulties

and second, the difference in the temperature of the water when starting from the tank or heater and its temperature on its return.

The higher the flow lines extend, the greater will be the acceleration of water on its downward course and the greater the differential temperature from the low cold point to the high hot point, the more rapidly will the flow lines deliver the hot water to the top of the building.

These two principles are made use of in a hot water circulating system. It then becomes apparent that the greater the distance from the top of the system to the bottom, the more gravity will help to increase the flow. Also if the return water goes directly to the point of lowest temperature, the greater will be the differential pressure to cause the water to flow. Then anything we can do to the piping system to increase the acceleration of gravity and the differential pressure will increase the circulation of water in the system and make the service more satisfactory.

Let us consider the return line in Fig. 3. It is shown to come from the top of the building and connect to the top of the tank which does not take all the advantage of the acceleration of gravity as might be done in Fig. 4. Some people would bring the return line in at the end of the storage about ⅓ of the way up. This would tend to maintain a strata of warm water on the top of the storage, but the writer's experience leads him to favor the long circuit principle as the storages are so small as compared to the total volume of the building piping that it cuts but little figure, and has the advantage that all the water available will be nearly of the same temperature whatever that might be.

Moreover, the difference of temperature so necessary to increase circulation of the storage to the system would be neutralized so far as temper-

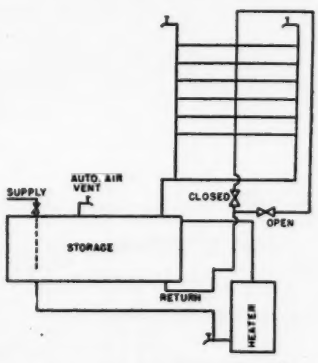


Fig. 5. Glenn Howell makes this suggestion that will add features to the system

ature is concerned and would not be satisfactory.

Regarding the make-up water from the city service, in Fig. 3, it is shown coming into the top of the tank where it would cool the hot water and pretty much ruin the hot water service.

It would seem very reasonable to take the make-up in at the lowest and coolest point as indicated in Fig. 4. In this way any water that is hot in the storage will stay hot and not be cooled by the make-up, only to be reheated again.

Third Prize Award

Glenn Howell
Canton, N. J.

FIGURE 5 is a sketch showing the correct pipe arrangement of your hot water system.

You will notice the following changes in the original layout:

1. The supply line is carried nearer to the bottom of the storage tank.

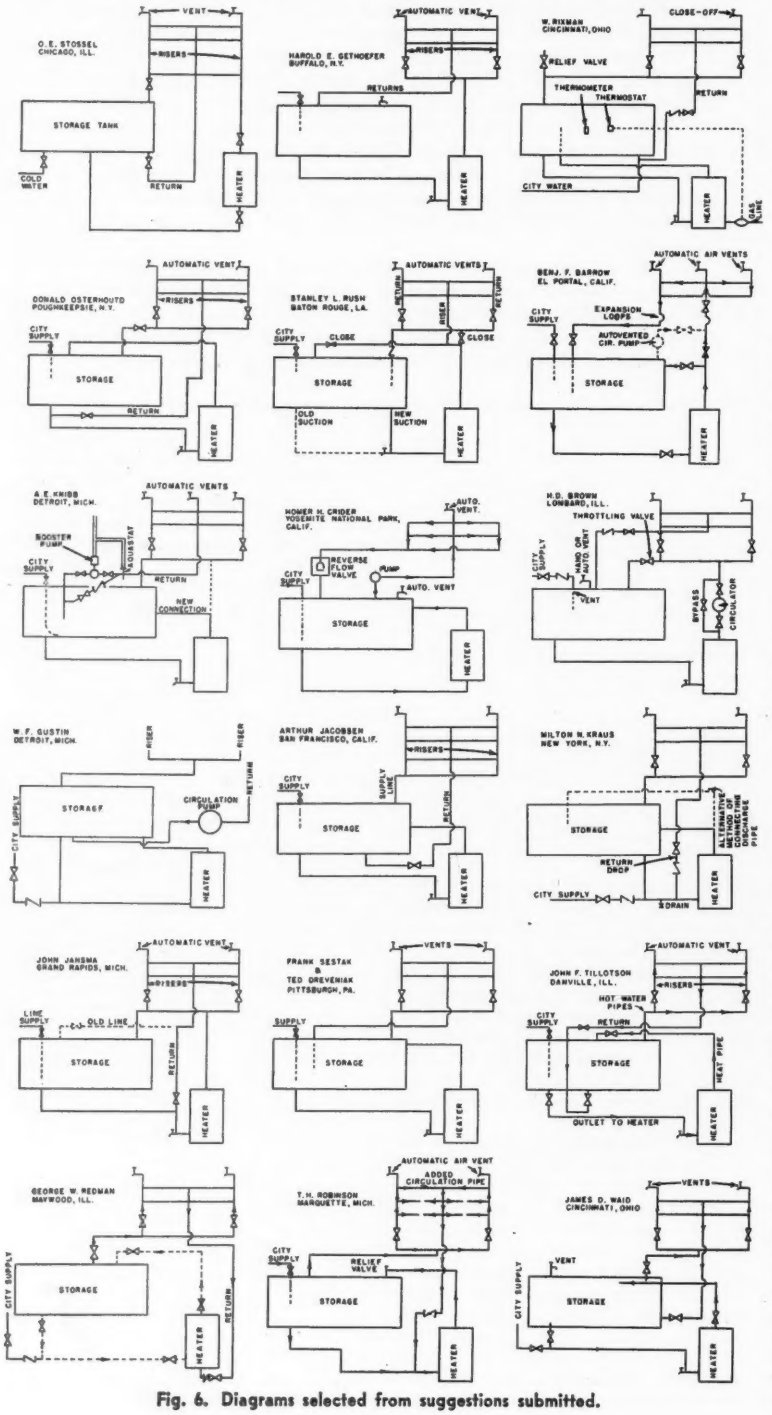


Fig. 6. Diagrams selected from suggestions submitted.

2. The hot water leaving the heater is carried only to the storage tank, entering near the top.

3. The hot water going to the risers is taken off at the top of the storage tank only. It is submerged 1 in. under the water in order to stay below the air. This one line will have to be as large as both risers from the storage tank to the risers.

4. An automatic air vent is put in top of the storage tank, possibly in the old return line connection.

5. A return line is connected in the top floor pipe runout and carried to the bottom of the storage tank as shown. You will notice it is connected to the old return line at the bottom of the building with valves on each one. The old return line valve is closed, new one opened. This convenience is provided in case you desire hot water in the lower stories only. It can be had by reversing the valve setting on the return lines.

Other Suggestions

That Our Hero would get better results if he tied his return pipe to the bottom of the storage tank is the opinion of James M. Reilly of Waltham, Mass., as well as a number of others as will be noted in the suggested diagrams. He is of the opinion that with present piping "This hot water under pressure tends to buck the water in the return, thus breaking up the cycle which must be maintained to have a positive circulation. If the return pipe were tied to the bottom of the tank in the coolest part, as the water in the highest part is cooled, it would become more dense. This would increase its weight and, consequently, its pressure per square inch at the bottom of the pipe. This difference in pressure would cause a positive flow in the return pipe into the storage tank."

"As can easily be seen (referring to the problem diagram)," quoting a statement by Donald Osterhoudt of Poughkeepsie, N. Y., "the only water that would get to the storage tank would be what little is forced back down through the return and you would get very little if any circulation between the heater and the storage tank. This hook-up would cause the water in the risers to become very hot, possibly boiling hot during the time when no water was being used. This probably causes the air bubbles. Just as soon as the water is driven out of the risers, the water would become cold because you would have very little hot water in the storage tank and the heater would not be able to heat it fast enough."

Several of the contestants would install circulating pumps and the suggested use of check valves to direct circulation was common in the letters submitted. A. E. Knibb of Detroit warns that "if the system is put in with steel pipe, the difficulties will become accentuated, owing to the deposits occurring on the inside of the pipe, until at last the installation is a source of great worry and inconvenience."

A GOOD RESOLUTION

For 1941
I am going to spend less time cleaning scale out of boilers, tubes, heaters, economizers and feed lines
I am going to get more steam from the coal we burn . . . . . .
I am going to get cleaner steam . . . . . .
I am going to use the NALCO SYSTEM
Nalco
—the Complete Water Treating Service

NALCO can help you keep your resolutions in 1941 and through the years to come. Changing over to the Nalco System is easy. It involves no additional capital investment and requires little, if any, rearrangement of plant operating equipment. Many customers report that the complete cost of Nalco Service is less than former costs for chemicals alone. We will be pleased to tell you about the Nalco System. Write.

NATIONAL ALUMINATE CORPORATION, 6224 West 66th Place, Chicago, Ill.

Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

Letters and Comments

"Verboten"

AFTER READING Mr. Williams' article, "Approaching Forty," I cannot help but feel that it is a feeble attempt to mask the real greedy motive of some manufactories for stamping "Verboten" upon its gates to men of forty and over. These companies have taken advantage of the past 10 years of depression to cut wages and to demand twice as much work from their employes. They have hired efficiency experts who stand over a man with a stop watch and then go back to their desk and figure out on paper that the man is not working fast enough, so he is told that he must put out so much more work per hour or else—

The result is the man of forty who takes a certain amount of pride in his work finds that he cannot put out the work they demand and do it right. He then becomes of the flinty, grumpy lot, almost impossible to get along with, grouchy and exhibiting no interest in his work or anything else. So out he goes and in comes the young inexperienced man, possibly just out of school, to take his place, who doesn't care how the work is done as long as he gets it out so he can collect on pay day and keep that date at night. Then there is the young man who is just out of college who is willing to work for almost nothing to get the necessary practical experience to fill in his education so that he can step into a job fitting to his education.

Some time ago I had an opportunity to watch a gang of men who were working for a concern who had taken advantage of the depression by replacing most of their old experienced men with younger inexperienced men at a lower wage scale. It kept the foreman busy going from one man to the other to tell him what to do next and how to do it. When they finished each operation they stood around and waited for the foreman to come and tell them what to do next. If half of these men were older experienced men with the younger men working as helpers the job would have been completed in about one-third of the time.

Just recently I read in the paper where this company had a fatal accident, one man was killed and several seriously injured. When this accident was investigated the blame was placed on the men because they neglected to fill a chamber with oil. Each one thought that the other had taken care of it and did not bother to check it.

If there had been sufficient number of older experienced men on this job I feel certain that this accident would not have happened. But "Verboten" has been stamped on the older experienced men who used to work for this company.

On the other hand there are countless number of leading concerns who point with pride to the men of forty and over in their employment who have had many years of practical experience and are proud of the fine work they have put out. Quite frequently you will even see them commercialize on the fact that they have several generations of one family working for them and that the many years of experience that these men have enable them to give the public the most up-to-date and newest developments at less cost.

This discounts Mr. Williams' claims that the man of forty and over is listed for the scrap heap and I think it is time we, the public, stamp "Verboten" on the products of those who have used the depression as an excuse to cut wages and production of inferior products for their own selfish gains.

DONALD OSTERHOUDT.

Pulverizer Pete Comes Out of Hibernation

Dear Electrical Editor:

I just gets through doing a little adding up and if I ain't wrong, it is pretty near again time for you to try to run the Practical Engineer.

Now maybe you is wondering why you don't see nothing by me in the Practical Engineer for perhaps a year, so I tells you that I figures them other two guys what took cracks at running it can do it without my help. Now also maybe you is wondering why you hears from me now, so I tells you I don't figure you can run it without my help.

While you was not hearing from me I was busy relaxing by going trout fishing and tuna fishing and duck shooting and to the World's Fair. Sometime I gradually tells you about these sports which I can do in not too many words. Take tuna fishing—you do this in the Atlantic Ocean or the Great Lakes. It is best you do it in the Atlantic on account a there ain't no tuna in the Great Lakes. First you charters a boat which costs forty bucks. You then gets three other guys to each pay ten bucks. The night before the trip you gives these three guys a bottle a Scotch. This is for to fix them up so they gets seasick quick the next day and you can do all the fishing. Next day you goes fishing —one outa three things happens: (1) You uses heavy tackle and catches baby fish which ain't no fun, (2) You uses light tackle and don't catch a big one that gets away, (3) You don't catch anything. That is tuna fishing.

Now about the World's Fair. I got a lot a interesting statistics about that what you are anxious to hear.

1. If all the neon and other glow discharge tubes was straightened out and laid end to end, they would reach 6.3418×10^{-40} of the distance to the fixed star Lysistrata.

2. If all the beer that got drunk in two years was put into a tank one quarter of a mile square it would float the Queen Mary and leave enough over to give every magazine editor in the United States a ten ounce drink.

3. The alcohol in the hard liquor that got drunk in two years would drive a S class submarine five times to Bermuda and back, if the fuel tanks didn't get corroded first.

4. The heat used in cooking all the hot dogs what got ate would keep all the strip teasers warm for three years.

I got still another thing to tell you about. That is I think I oughta write you a article about safe firing of modern steam generators. There was a lot of development by me in this field lately so maybe pretty soon I tells you about my invention of a explosion proof furnace.

Now I sees where I still got time to inform you about duck shooting. Duck shooting is a great sport. You gets up before daylight and goes to a mudhole in a swamp with a lot of weeds all around the hole. That is called a blind—it is also called a ice box because it is supposed to make you look like a frozen rock to the ducks. You gets in the blind and sits in a half a inch of ice water and pretty soon the sun comes up. Or maybe it is raining and the sun don't come up.

Pretty soon you hears ducks a quacking . . . then you hears the beat of their wings . . . then you sees them . . . then they flies by outa range. Now another flock shows up . . . they is dumb ducks . . . they come closer and closer . . . you can almost feel their hot breath on the back of your neck . . . you picks up your trusty double . . . you raises it to your shoulder . . . your cheek cuddles against the stock . . . the ivory bead stands out clear in the gathering light . . . you aims . . . you fires, twice . . . you misses, twice. That is duck shooting.

Now in finishing, here is a problem the solution to which I would like to get dissolved.

Problem: A radio amateur has got (honestly) the following stuff:

- **2 50 watt tubes 1000 v. max. plate**
- **1 ¼ KW transformer from an old spark transmitter**
- **4 good 45 v. "B" batteries**
- **1 24 v. electric bell**
- **1 Class B transformer 250 mills, ratio 1.1:1, burned out secondary**
- **6 8 mfd. electrolytic condensers**
- **Key, misc. wire, resistors, nuts, etc.**

How should he use this equipment to communicate the greatest distance with it?

To everybody what sends me a right answer and a self-addressed stamped envelope and a unused three cent stamp to pay me for my trouble I sends gratis without charge a steel engraving of a prominent American. Please don't nobody send no box tops and don't write no poetry or tell me why you likes Pulverizer Pete in 25 words.

Very truly yours,

X

PULVERIZER PETE.

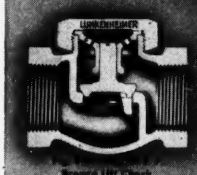
NO. 10 OF A SERIES

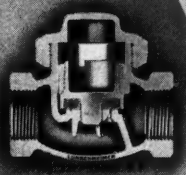
*Top view showing Two Renewable Side Plugs. An original feature of dependability found in all Lunkenheimer Swing Check Valves.

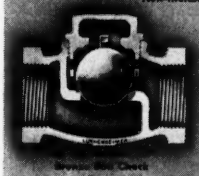
Where Dependability is the Measure of Valve Economy

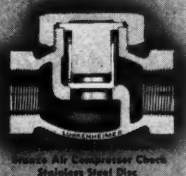
LUNKENHEIMER CHECK VALVES

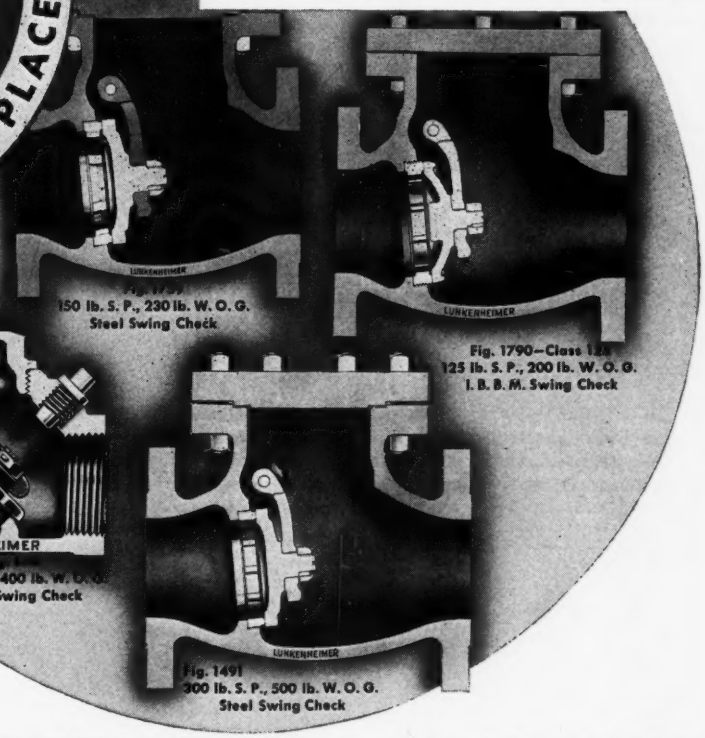
ARE "CORRECTLY ENGINEERED" FOR MAXIMUM ECONOMY ON THE JOB!


Bronze Lift Check


Bronze "Hi-Hi-D" Lift Check Non-Metallic Disc


Bronze Disc Check


Bronze Air Compressor Check Stainless Steel Disc



150 lb. S. P., 230 lb. W. O. G. Steel Swing Check

Fig. 1790—Class 125 lb. S. P., 200 lb. W. O. G. I. B. B. M. Swing Check

200 lb. S. P., 400 lb. W. O. G. Bronze Swing Check

Fig. 1491 300 lb. S. P., 500 lb. W. O. G. Steel Swing Check

● DEPENDABILITY in check valves is important! Their satisfactory performance means safe operation and protection of valuable equipment. They must be tight; they must stand guard against reverse flow in a line, which might endanger not only equipment and processes, but human life as well; they must protect low pressure sections of systems in which both low and high pressures are used.

Any need for a check valve should suggest caution and the exercise of every care in its selection. No other valve is more important.

*All Lunkenheimer Swing Check Valves are provided with two renewable side plugs which serve as bearings for the disc carrier pin. Should a pin become worn, causing misalignment and ineffective operation of the valve, it can be removed from either side—a particularly advantageous feature when valves are installed close to a wall.

SEEING IS BELIEVING

Every year, many valve buyers visit the Lunkenheimer plants in Cincinnati. They've been told about "Correctly Engineered" Valves . . . they come to see, to inspect the iron foundry, the steel foundry, the metallurgical research laboratories, and watch, at first hand, the finer manufacturing in these great valve plants . . . they go away *sold*—not only on a product, but sold on the processes they never before knew went into the manufacture of a "mere valve."

Your Lunkenheimer distributor will gladly show you the many points where "engineered superiority" in Lunkenheimer Bronze, Iron and Steel Check valves guarantees accuracy, safety, and low cost service.

ESTABLISHED 1862

THE LUNKENHEIMER CO.

"QUALITY"

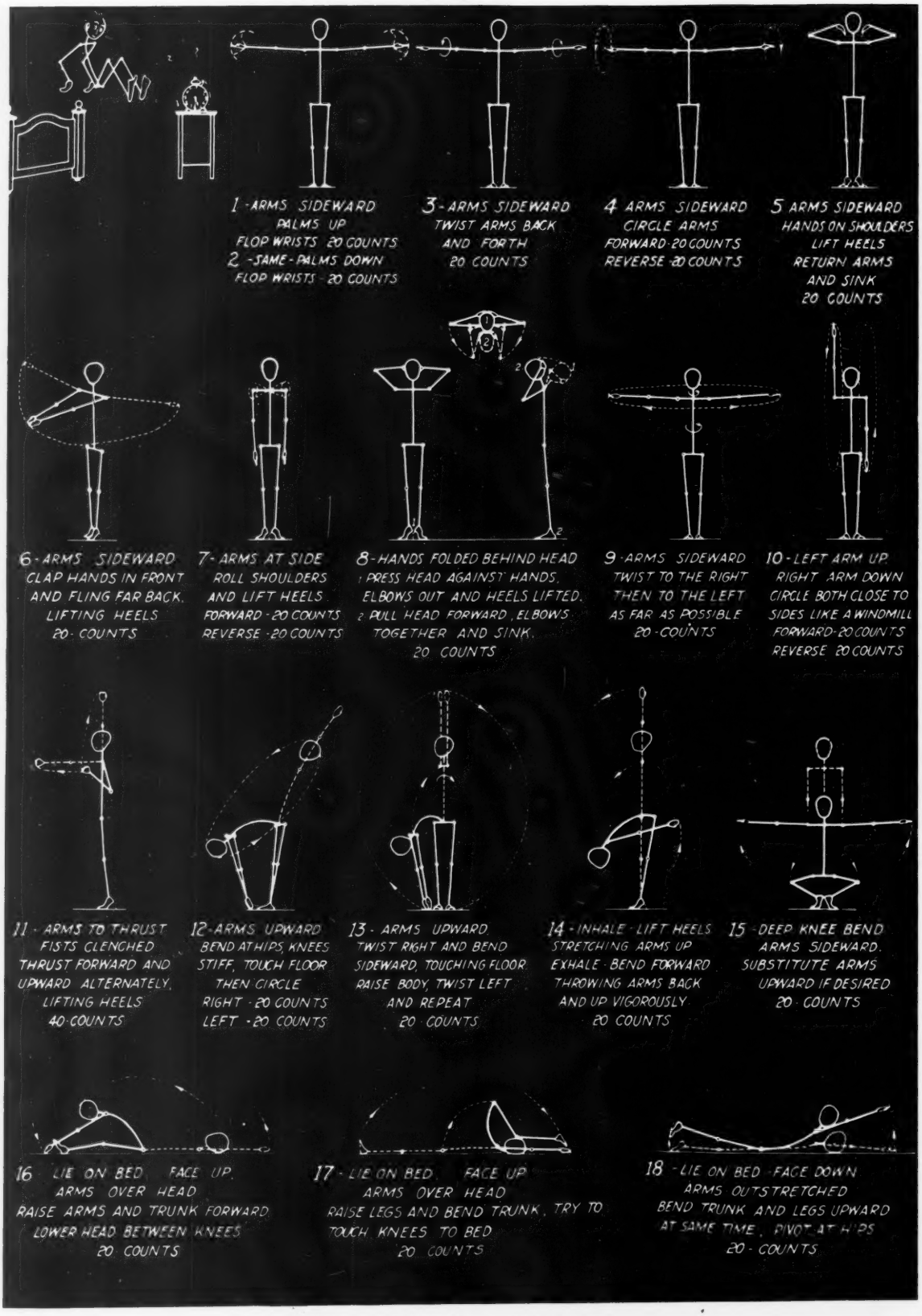
CINCINNATI, OHIO, U. S. A.

NEW YORK CHICAGO
BOSTON PHILADELPHIA

EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

LUNKENHEIMER

Send for copy of our new Catalog No. 78. We will include our handy "Guide", for easy selection of valves, boiler mountings, and lubricating devices according to pressures, temperatures, and service applications.



Maintenance Chart for Practical Engineers

BETZ SERVICE

INCLUDES

BOILER FEEDWATER
PROCESS WATER
MUNICIPAL SUPPLY WATER
WASTE DISPOSAL—RECLAMATION

PLANT STUDIES
PLANT DESIGN
CONSULTATION
SUPERVISION

Some folks take their celebrations too seriously,—hence the Water Wagon as a time honored symbol of the New Year resolution. On the other hand, some people don't take their headaches seriously enough and their water problems become a perpetual headache. Every year, however, finds hundreds of Plant Executives seeking a definite solution of their water problems, and turning to the chemical engineering service offered by Betz.

Start the New Year right, right now! Assure yourself and your plant personnel, a Happy New Year throughout 1941, in-so-far as your water and steam is concerned. Follow the trend of the field, toward the best available service for water conditioning—Betz Service. When you think of water, think of Betz!

• The BETZ INDICATOR is mailed without charge to Plant Executives—9000 every month. Write for your FREE copy.

CABLE ADDRESS: BETZPHIL : BENTLEY CODE

W. H. & L. D. Betz

Chemical Engineers and Consultants on All Water Problems

General Offices and Laboratories at 235 W. Wyoming Avenue, PHILADELPHIA, PENNA. • *Branch Offices at* 50 Church Street, NEW YORK • 37 W. Van Buren Street, CHICAGO • 506 Dime Bank Bldg., TULSA • Betz Laboratories Division, Wood Industries, Ltd., Royal Bank Bldg., MONTREAL • 906 New Wellington Bldg., TORONTO

Clearing The R

Fig. 1. (Above) Heavy tractor equipment used to construct access roads over high precipices and into deep gorges for men and materials. Transmission lines are run well back from the highways of the Columbia gorge to avoid marring the scenic beauty of the Columbia gorge which attracts thousands of tourists annually

Fig. 2. (Above) Aerial view showing the rugged and mountainous country through which WPA cleared a path from 150 to 300 feet wide for the Bonneville Power Transmission lines

Fig. 3. (Left) Up hill and down, workers clearing for transmission line through the Cascade regions. Service roads built by WPA will later be used to maintain and service power line

CLEARING the right-of-way for the vast network of transmission lines which will distribute the power generated at Bonneville Dam to cities, farms and industries is one of the most important current activities of the Work Projects Administration in the State of Washington. The scope of this project, the rugged and difficult terrain that is being cleared, and the increasing importance of electric power to both national growth and defense has focused attention on its operations.

This huge clearing undertaking is one of many such WPA projects which have been operated in conjunction with the great power, navigation, and irrigation developments on the Columbia River. The engineering feats performed on the main dam structures of Grand Coulee and Bonneville are so spectacular that little is heard of these attendant projects which are vitally important to their successful completion and operation.

The Bonneville Transmission line clearing project has been in operation since 1938, when five separate projects sponsored by the Bonneville Authority were approved with a total of $3,425,667 in Federal funds and $804,391 in Sponsor's funds.

The master plan of the Bonneville network to date includes three main transmission lines running out of the Bonneville substation at Vancouver. This will necessitate a total of more than 550 miles of right-of-way clearing and the building of access roads over mountains and through heavy timber.

The estimated work for the projects approved and now operating includes the clearing of 439 miles of this total loop. The right-of-way, 100 feet, 250 feet,

Right-of-way For The Bonneville Power Lines

and 300 feet wide, involves approximately 13,300 acres of clearing. Fifty per cent of this is through heavy timber, thirty per cent is medium heavy clearing and the balance is light timber and brush clearing. Approximately 476 miles of access roads, which will later be used as maintenance roads for the power lines, are included in this work. This includes the construction of some 10,000 linear feet of culverts and timber bridge construction.

One of the main lines in this network, the Bonneville-Yakima-Grand Coulee Line, which will tie the Bonneville Dam in with the Grand Coulee project covers a distance of 239 miles. Starting at Bonneville Dam this line proceeds in an easterly and northeasterly direction by way of Yakima County to Grand Coulee, passing through Skamania, Klickitat, Kittitas, Benton, Grant, Chelan, Douglas and Lincoln counties. Much of this line passes over the Cascade Range, leading over high precipices, deep gorges and loose shale which presents difficult transportation problems.

(Continued on Page 100)

Fig. 4. (Above) About eight miles from Vancouver, Washington, showing right-of-way clearance, towers and power line in place

Fig. 5. (Left) Heavy brush, small standing trees and dead snags cover much of the clearing area. Falling dead snags is hazardous work. Burning of brush and debris in this 150-to-300 foot wide strip presents difficult fire problems. Skamania County

Fig. 6. (Below) Camp Willard, located 62 miles from Vancouver. This camp was the first of three 250-men camps on the Vancouver-Yakima line to house men clearing the area through the Cascades, remote from towns and cities. The camps are thoroughly modern, equipped with plumbing, electric lights, showers, a hospital and other conveniences. Mess hall, blacksmith shop, warehouse and office quarters are included in the camp set-up

FORCE, WEIGHT, MASS A

BY ALLEN KELLER
Turbine Engineering Department
General Electric Company
Lynn, Massachusetts

Once in a blue moon (whatever that means) we are able to present an article that is different from the conventional run of technical and semi-technical articles. This is one of those occasions. This consideration of Force, Weight, Mass and Acceleration by Allen Keller is unusual, to say the least, and quite obviously, something he initiated himself. In his work in the Turbine Engineering Department of the General Electric Co. at Lynn, he naturally has considerable opportunity to sling B.t.u.'s around and so he thinks about them somewhat more than the rest of us. So, in this article he has put some of his thoughts on paper and among other things shows that with our generally accepted concepts of weight, mass, heat value, etc., a turbine designer on Mars would run into a lot of trouble. Perhaps, none of you contemplate going to Mars but, even so, you should read this article, if, for no other reason for the mental gymnastics it provides.

MUCH CONFUSION EXISTS in engineering circles concerning the distinctions between force, weight, and mass. The following discussion sets forth the writer's understanding of the real significance of these concepts, together with that allied entity, acceleration, in a way which he believes to be readily understandable. Specifically, we shall consider these concepts in connection with steam turbine design.

At the outset, it may be well to remark that it is not contended that the viewpoint set forth in this article is the only logical viewpoint, but only that it is a logical and consistent viewpoint and the one which the writer prefers to hold in his everyday work. It is believed, however, that anyone with a thorough understanding of the contents of this article will have little difficulty in discussing and understanding the subject when viewed from any other angle.

In the United States there are several steam turbine manufacturers whose plants are located at various points in the country. All of these manufacturers use identical steam chart data when predicting the performance of their products; also, the same steam data are used when turbines of United States manufacture are tested at any point in the world. Foreign turbine manufacturers use essentially the same data.

These steam charts, both domestic and foreign, are based on empirical determinations of the properties of water and steam and give values of enthalpy (total heat before the depression) in terms of entropy, pressure, temperature, and so forth. Enthalpy is commonly expressed in terms of B.t.u. per pound. What is the nature of a B.t.u. (British Thermal Unit); what is the nature of this pound; and what is the nature of this B.t.u. per pound, which make it permissible to use the same steam chart for turbine design and manufacture at Lynn, Massachusetts, at Schenectady, New York, on the planet Mars, or at a point in space where the net force of gravity is zero?

What is the nature of a B.t.u.?

First of all, some definitions of the fundamental entities involved are required. These may be found in Table 1. The reader may take his choice between the "man-in-the-street definitions" or the "more general and more exact definitions." In this article, in general, we will try to think in terms of absolute values and absolute units. An apparently insurmountable difficulty occurs in the case of absolute work and absolute energy due to our inability to evaluate absolute distance through space. With work measured as force times the distance through which the force is applied, absolute work involves a knowledge of absolute distance and who can measure absolute distance in space? This point, however, need not disturb the reader; we will make an engineering attack on the problem considering work and energy relative to the earth or other fixed reference point.

The Nature of the B.t.u. and of the Pound

For the purpose of this discussion, the nature of the B.t.u. will be disposed of quickly. Most engineers will recall the B.t.u. is defined as the amount of heat required to raise the temperature of one pound (mass) of water one degree Fahrenheit (at specified temperature and pressure condition). Strictly speaking, this definition no longer holds; however, since it is the one with which most engineers are familiar, it is the one which will be used in this discussion. As such, the B.t.u. will be accepted as a unit for the measurement of energy and work.

The B.t.u. was originally defined as given above. From time to time, various temperature ranges have been used. In the Keenan steam table published by the A.S.M.E. in 1930, the B.t.u. was defined in terms of enthalpy units instead of heat units. This introduced a change of a small

AND ACCELERATION

fraction of one per cent in the size of the B.t.u.

After the 1930 Keenan steam table data had been worked up but before they were published, the B.t.u. was, by international agreement, redefined in terms of international electrical units. There is now an international agreement that the international electrical units are to be abandoned and it is probable that future steam tables will use a B.t.u. defined, directly or indirectly, in terms of absolute mechanical units (force or mass, length, and time). These various changes have been made to help engineering approach more closely to an exact science, are for the convenience of engineers and scientists when doing super-accurate work, and do not affect the nature of the B.t.u. as a unit for the measurement of heat, energy, and work. Within the accuracy of ordinary engineering work, the difference in the size of the B.t.u. according to the various definitions may usually be neglected.

Next, consider the nature of the pound in B.t.u. per lb., used as a measure of *specific enthalpy. Is it a unit of force, weight, standard weight, or mass? What must it be if the same steam chart is to be used on the moon as on the earth?

In the first place, the B.t.u. per lb. given on the steam chart is used as a measure of the energy corresponding to a given quantity (number of molecules) of steam. This pound, then, must be a measure of the quantity of steam. But we have no direct measure of the quantity of matter; none of the definitions previously referred to say anything about the quantity of matter.

At this point, nature simplifies the problem for us, at least it is simplified for all ordinary engineering work. Although we have no direct measure of quantity of matter, the inertia or mass of any given number of atoms of any

*The word "specific" in specific enthalpy indicate that the enthalpy of only one pound of steam is being considered. Enthalpy is an extensive quantity; the enthalpy of ten pounds of steam is ten times the enthalpy of one pound. In most engineering discussions, it is understood that the properties of only one pound of steam are being considered and the word "specific" is omitted.

TABLE I.

ENTITY	MAN-IN-THE-STREET DEFINITION	MORE GENERAL AND MORE EXACT DEFINITION
Gravitational Attraction	Same as Gravity.	The force of attraction between matter under consideration and all other matter in the universe due solely to the mass and location of all matter in the universe.
Gravity	That property of the earth which causes it to draw all objects on or near its surface towards its center.	Gravitational attraction corrected for all centrifugal and other force effects of the rotation and motion of the earth and all other heavenly bodies.
Weight	The force exerted by gravity on any object.	The net force of gravity acting between matter under consideration and all other matter in the universe.
Force	The "push" required to give motion to anything which has weight.	That entity which is required to overcome inertia and cause a change in the motion of matter.
Mass	That property of matter which causes it to have weight.	That property of matter which causes it to have inertia or resistance to change of velocity (speed and direction) of motion.
Standard Weight	The weight any object would have if placed at a point on the earth's surface where gravity is equal to the agreed-to standard gravity which is approximately the average gravity over all the earth's surface.	The net force gravity would exert on any given quantity of matter if placed at any point in the universe where the net force of gravity per unit mass under consideration has an agreed-to standard value.
Acceleration due to Gravity	The acceleration of a free body falling towards the earth's surface.	The local linear acceleration of a free body at any point in the universe due to the force of gravity at the point where the body is located.
Standard Acceleration due to Gravity	The acceleration of a free body falling towards the earth's surface at a point where gravity is equal to the agreed-to standard gravity.	The linear acceleration due to the net force of gravity which would act between a body and all other matter in the universe if the body were placed at any point in the universe where the net force of gravity per unity mass of the body was equal to the agreed-to standard value.
Work	The mechanical energy required when a force is applied to a moving body. (Work is measured as the product of a force by the distance through which the force is applied.)	The transformation of energy in any form to such form as would cause an unrestrained body to accelerate. (This concept appears rather useless in an absolute system due to the difficulty of evaluating absolute distance in space.)
Energy	Stored work or its equivalent in any other form.	That entity which can cause change in the state of matter. (In an absolute system, energy appears to be a rather useless concept for the reason that absolute work cannot be evaluated.)
Inertia	The force resistance of matter to acceleration.	The resistance of matter to change of velocity (speed and direction) of motion.

given chemical element appears to remain constant regardless of what form the element may be in or with what other elements it may be combined; also, the force of standard gravity on a given number of atoms of a given chemical element appears unchangeable. The writer can think of no inherent reason why this should be true, in fact Einstein can think of reasons why it should not be true, but experience shows it to be sufficiently accurate for all engineering work. Sufficiently accurate engineering instruments have not yet been developed for measuring any change in the inertia of a given number of atoms of a given chemical element.

Perhaps an example will clarify just what is meant. Consider a closed container which encloses given quantities of hydrogen and oxygen. The enclosed gases will each have a definite inertia and standard gravity will exert a definite force on each gas. Now apply heat to the container and the gases will react chemically to form water vapor or steam. Since the container is totally enclosed, by the law of the conservation of matter the steam will represent the same quantity of matter that was formerly represented by the hydrogen and oxygen gases that went into the reaction. But, should it turn out that the mass and inertia of the enclosed gases had been changed by the chemical reaction even to the extent of a very small fraction of one per cent, should we or should we not then say that the quantity of matter had remained constant? At any rate, in the popular mind quantity of matter and mass are synonomous and experience shows that ordinary chemical reactions do not change the total mass of the elements to any measurable extent. The temperature, pressure, entropy, and so forth will be changed by our chemical reaction; why do not the mass and inertia also change? Try to prove analytically that they will not.

It appears, then, that although we have no direct measure of quantity of matter, for engineering work both inertia (measured in mass units) and standard weight (measured by the product of mass units and an agreed-to standard acceleration due to gravity) are always directly proportional to the quantity of matter. Therefore we can use either of these entities as a criterion of the quantity of matter.

We conclude, therefore, that the pound in B.t.u. per pound may be either a pound standard weight or a pound mass, either of which may be taken as a measure of the quantity of matter. The pound mass is the much more fundamental concept, however. The definition of the pound standard weight involves stating what the force of gravity on a given quantity of matter would be if the matter were located at a point where gravity has a standard value. To define any quantity in terms of what it would be if certain external conditions were satisfied may be rigorous but it is not a practice to be recommended generally. When little Johnny tells teacher that "an apple is the fruit you would pick if you picked fruit from an apple tree" he has not given a very vivid description of an apple. (And it so happens that this particular definition is inaccurate, or at least ambiguous, because one might pick pears from a pear branch grafted on an apple tree.)

Our pound cannot be a pound force. We are looking for a pound that is a measure of the quantity of matter, and a force, in itself, can never be a measure of matter.—There is no hard and fast relationship (although there may be an approximate one) between the size of a boxer and his "punch".

Neither can our pound be a pound weight if we are to use the same steam chart at points of different gravity. Since the weight of a given body or quantity of matter varies directly with the acceleration due to gravity, a pound weight represents different quantities of matter at different locations.

As a final conclusion, then, the pound in B.t.u. per pound could be either a pound standard weight or a pound mass; but since a pound standard weight is inherently a more involved concept than a pound mass (maybe not for many individuals), we will rule out this concept and definitely state that it is a pound mass. The writer is willing to predict that any group of engineers or scientists working on several planets where gravity varies over wide limits would soon throw out the concept of standard weight as unnecessary and confusing to use.

Acceleration

We have now disposed of the B.t.u. and the pound. Before further considering the nature of the combined concept, B.t.u. per pound, it will be necessary to give detailed consideration to acceleration.

Anyone who has studied mechanics will recall the equation

$$\text{Force} = \text{Mass} \times \text{Acceleration} \quad (1)$$

This is really the fundamental equation by which the unit of force is defined in all systems of measurement, metric, English, and so forth. In the absolute metric system, the unit of force, the dyne, is defined as the force required to impart to a mass of one gram an unrestrained acceleration of one centimeter per second per second.
Then,

$$\left(\begin{array}{c}\text{Force,}\\ \text{in}\\ \text{dynes}\end{array}\right) = \left[\begin{array}{c}\text{Mass, in}\\ \text{grams}\end{array}\right] \times \left[\begin{array}{c}\text{Accele-}\\ \text{ration,}\\ \text{in cm.}\\ \text{per sec.}\\ \text{per sec.}\end{array}\right] \quad (2)$$

Had Mr. C. G. S. (centimeter-gram-second, the absolute metric system) seen fit, he could just as well have defined the dyne as the force required to give a mass of one gram an unrestrained acceleration of two centimeters per second per second. The force defining equation would then read

$$\left(\begin{array}{c}\text{Force,}\\ \text{in nu-}\\ \text{dynes}\end{array}\right) = \tfrac{1}{2} \times \left[\begin{array}{c}\text{Mass, in}\\ \text{grams}\end{array}\right] \times \left[\begin{array}{c}\text{Accele-}\\ \text{ration,}\\ \text{in cm.}\\ \text{per sec.}\\ \text{per sec.}\end{array}\right] \quad (3)$$

A generalized force-defining equation, then, would seem to be

$$\text{Force} = \text{Constant} \times \text{Mass} \times \text{Acceleration} \quad (4)$$

where the constant will depend on the units used and may be

A pound is sometimes subject to question.

arbitrarily selected when first defining a new set of units but must be properly adjusted when any other units of measurement are used.

Now the practical English scientists, well knowing that the ordinary man-in-the-street would have difficulty distinguishing between the concepts of force, weight, and mass (and I have been told that a few engineering college graduates have the same difficulty), long ago said: "We'll define the units of force and weight in such ways that the ordinary grocer will weigh out approximately the proper quantity (mass) of sugar on his spring scales or balances even if he doesn't know what he is doing. By experiment it has been determined that the average acceleration due to gravity on this earth is approximately 32.1740 (they weren't quite sure about the last cypher in the early days) feet per second per second so we'll define the unit of force by the equation

$$\begin{bmatrix}\text{Force, in}\\ \text{pounds}\end{bmatrix} = \frac{1}{32.1740} \times \begin{bmatrix}\text{Mass, in}\\ \text{pounds}\end{bmatrix} \times \begin{bmatrix}\text{Acceleration,}\\ \text{in ft. per}\\ \text{sec. per sec.}\end{bmatrix} \quad (5)$$

By this subtle trick played on the unsuspecting public, they arranged that at any point on this planet gravity would exert a force of approximately one pound on a mass of one pound, and for ordinary commercial transactions the public would never need to be told that there is a difference between force, weight, and mass, that they are, in fact, as different as are pigs, cows, and horses.

Looking back on all this, the surprising thing is that special groups of workers have not demanded special definitions or equations for the force unit. For instance, the whale fisherman, wishing to calculate the strength of harpoon line he would need, might well demand the equation

$$\begin{bmatrix}\text{Force required}\\ \text{to accelerate}\\ \text{the whale to-}\\ \text{wards the boat,}\\ \text{in pounds}\end{bmatrix} = 372.97 \begin{bmatrix}\text{Mass of}\\ \text{whale, in}\\ \text{short tons}\end{bmatrix} \times \begin{bmatrix}\text{Acceleration}\\ \text{of whale, in}\\ \text{fathoms per}\\ \text{sec. per sec.}\end{bmatrix} \quad (6)$$

Or little Johnny, out beating rugs, in England, when he would much rather be fishing, if he were mathematically inclined might insist that the basic defining equation for the force unit, from which all other equations are derived, read as follows:

$$\begin{bmatrix}\text{Force re-}\\ \text{quired to}\\ \text{accelerate}\\ \text{carpet}\\ \text{beater, in}\\ \text{long tons}\end{bmatrix} = \begin{matrix}0.000{,}000{,}-\\ 000{,}000{,}-\\ 000{,}000{,}-\\ 002{,}671{,}4\end{matrix} \begin{bmatrix}\text{Mass of}\\ \text{Beater,}\\ \text{in}\\ \text{English}\\ \text{hundred}\\ \text{weight}\end{bmatrix} \times \begin{bmatrix}\text{Linear acceler-}\\ \text{ation of beater,}\\ \text{in millimeters}\\ \text{per week per}\\ \text{standard cen-}\\ \text{tury}\end{bmatrix} \quad (7)$$

where the standard century consists of 100 years of 365 97/400 days each.

Each of the above force equations involves the concept of mass, which many engineers and other people do not like to contemplate. For most engineering work, force is considered as defined by the equation

$$\text{Force} = \frac{\text{weight}}{\text{acceleration due to gravity}} \times \text{Acceleration} \quad (8)$$

Or,

$$\text{Force} = \frac{\text{Standard weight}}{\text{Standard acceleration due to gravity}} \times \text{acceleration} \quad (9)$$

However,

$$\text{Weight} = \text{Constant} \times \text{Mass} \times \text{Acceleration due to gravity} \quad (10)$$

and

$$\text{Standard Weight} = \text{Constant} \times \text{Mass} \times \text{Standard acceleration due to gravity} \quad (11)$$

If these weight equations are substituted in the engineering force equations, the accelerations due to gravity cancel out resulting in the fundamental equation.

$$\text{Force} = \text{Constant} \times \text{Mass} \times \text{Acceleration} \quad (12) = (4)$$

For many engineering calculations, the difference between gravity at the location under consideration and standard gravity is neglected, and force is calculated as follows:

$$\text{Force} = \frac{\text{Weight}}{\text{Standard acceleration due to gravity}} \times \text{Acceleration} \quad (13)$$

The Nature of the B.t.u. Per Pound

We are now in a position to further examine the nature of the B.t.u. per pound (mass). As previously stated, the B.t.u. is a measure of heat, work and energy. Also the foot-pound is a measure of work and energy, and this pound is definitely a pound force as work is represented by the product of force and distance or pounds and feet.

Since by the first law of thermodynamics energy can neither be created nor destroyed, and since the B.t.u. and the foot-pound are both measures of work and energy, it follows that there must be a definite, fixed relationship between these two units of measurement. The ratio of the amount of energy represented by a B.t.u. to that represented by a foot-pound has been given the symbol "J".

With the B.t.u. defined as the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit, the relationship between the size of a B.t.u. and the size of a foot-pound cannot be calculated and can be determined only by experiment. Also, with the B.t.u. defined in terms of international electrical units, the same thing applies. When the B.t.u. is defined in terms of mechanical units, however, there will be, by definition, an exact, unchangeable relationship between the size of a B.t.u. and the size of a foot-pound. This is the principal reason why the new definition is desired.—With the original definition of the B.t.u., we knew that it took exactly one B.t.u. to raise the temperature of one pound of water one degree Fahrenheit (at the proper temperature and pressure conditions), but we did not know the exact relationship between a B.t.u. and a foot-pound. With a new definition of the B.t.u. in terms of mechanical units, we will have an exact relationship between a B.t.u. and a foot-pound, but we will not know exactly how many B.t.u.'s it takes to raise the temperature of one pound of water one degree Fahrenheit.

The expression, B.t.u. per pound mass, can therefore be replaced by an expression in terms of foot—(pounds force) per pound mass, thus

$$\frac{\text{B.t.u.}}{\text{pound mass}} \times J = \frac{\text{foot—(pounds force)}}{\text{pounds mass}} \quad (14)$$

A better way of expressing the same thing, which is correct both dimensionally and numerically, is

$$\frac{\text{Energy, in B.t.u.}}{\text{Mass, in lb.}} \times J = \frac{\text{Energy, in foot—(lb. force)}}{\text{Mass, in lb.}} \quad (15)$$

But from the conventional manner of measuring work, when a free body is accelerated by a force

$$\text{Work, in foot—(pounds force)} = \int \left[\begin{matrix}\text{Force,}\\ \text{in lb.}\end{matrix}\right] \times \mathrm{d}\left[\begin{matrix}\text{Distance,}\\ \text{in ft.}\end{matrix}\right] \quad (16)$$

and from equation (5)

$$\text{Force, in lb.} = \frac{1}{32.1740} \times \left[\begin{matrix}\text{Mass,}\\ \text{in lb.}\end{matrix}\right] \times \left[\begin{matrix}\text{Acceleration,}\\ \text{in feet per}\\ \text{sec. per sec.}\end{matrix}\right] \quad (5)$$

Combining equations (5), (15), and (16), we get as the kinetic energy or work done

$$\frac{\text{Energy, in B.t.u.}}{\text{Mass, in pounds}} = \frac{1}{J} \frac{\int (\text{Force, in lb.}) \times \mathrm{d}\ (\text{Distance, in ft.}}{\text{Mass, in pounds}} \quad (17)$$

$$= \frac{\int \frac{1}{32.1740} \times \left[\begin{matrix}\text{Mass,}\\ \text{in lb.}\end{matrix}\right] \times \left[\begin{matrix}\text{Accelera-}\\ \text{tion, in ft.}\\ \text{sec. sec.}\end{matrix}\right] \times \mathrm{d}\left[\begin{matrix}\text{Distance,}\\ \text{in ft.}\end{matrix}\right]}{\text{Mass, in pounds}} \quad (18)$$

$$= \frac{1}{J \times 32.1740} \times \int \left[\begin{matrix}\text{Acceleration, in}\\ \text{ft. per sec. per}\\ \text{sec.}\end{matrix}\right] \times \mathrm{d}\left[\begin{matrix}\text{Distance,}\\ \text{in ft.}\end{matrix}\right] \quad (19)$$

$$\text{But,} \left[\begin{matrix}\text{Acceleration, in ft.}\\ \text{per sec. per sec.}\end{matrix}\right] = \frac{\mathrm{d}\ (\text{Velocity, in ft. per sec.})}{\mathrm{d}\ (\text{Time, in sec.})} \quad (20)$$

$$\text{and d (Distance, in ft.)} = \left[\begin{matrix}\text{Velocity, in}\\ \text{ft. per sec.}\end{matrix}\right] \times \mathrm{d}\left[\begin{matrix}\text{Time,}\\ \text{in sec.}\end{matrix}\right] \quad (21)$$

Therefore,

$$\frac{\text{Energy, in B.t.u.}}{\text{Mass, in lb.}} = \frac{\int \left[\begin{matrix}\mathrm{d}\ (\text{Velocity, in}\\ \text{ft. per sec.})\\ \mathrm{d}\ (\text{Time, in sec.})\end{matrix}\right] \left[\begin{matrix}\text{Velocity,}\\ \text{in ft. per}\\ \text{sec.}\end{matrix}\right] \left[\begin{matrix}\mathrm{d}(\text{Time,}\\ \text{in sec.}\end{matrix}\right]}{J \times 32.1740} \quad (22)]$$

$$= \frac{\int [\text{Velocity, in ft. per sec.}] \times [\mathrm{d}\ (\text{Velocity, in ft. per sec.})]}{J \times 32.1740} \quad (23)$$

which, when the initial velocity is zero.

$$= \frac{[\text{Velocity in feet per second}]^2}{2 \times J \times 32.1740} \quad (24)$$

Of course, the energy in B.t.u. per pound referred to in these equations is the kinetic energy equivalent of velocity and has no inherent connection with the energy represented by the enthalpy of the steam.

Equation (24) shows that the B.t.u. per pound is of the nature of velocity squared. Also, it should be particularly noted that the quantity 32.1740 *is not* the standard acceleration due to gravity but is a dimensionless number which is numerically equal to the standard acceleration due to gravity when expressed in feet per second per second; it is the dimensionless constant of equation (5).

Since neither the acceleration due to gravity nor the standard acceleration due to gravity appear in equation (24), it is apparent that the relationship between the B.t.u. per pound and velocity is entirely independent of gravity. Let us carefully examine this conclusion.—Regardless of what definition is used for the B.t.u., it is a definite quantity of energy which neither gravity nor anything else can alter. Likewise, the foot is a definite, unalterable unit of length, and the second is an independent unalterable unit of time. Therefore, a foot per second is a definite velocity, which, when imparted to one pound mass of matter, represents a definite kinetic energy which cannot be affected by gravity. As stated previously, J is a definite, constant conversion factor which is inherently fixed as long as the force unit remains unchanged, and any change of the force unit will change J and the constant 32.1740 in exact inverse relationship. It is therefore apparent that the relationship between B.t.u. per pound mass and velocity should be entirely independent of gravity, and any equation which appears to indicate differently may be misleading, to say the least.

Much of the confusion concerning the acceleration due to gravity lies in the fact that most engineers think of the force unit as inherently defined by the standard acceleration due to gravity. The force unit should not be viewed in such light. If we are to use the same equations of mechanics on the sun as on the earth, we must think in terms of absolute force units and absolute units of measurements for all other entities. If the standard acceleration due to gravity is changed and a new definition of the force unit is made, then previous equations will no longer apply, but they will need revision because the unit of force has been changed, not because standard gravity has been changed. A change in the size of the force unit should be considered in exactly the same light as a change in the mass unit, the length unit, or the time unit, a change of any one of which will necessitate a revision of the constants in many of the relationships of mechanics.

J may be considered as a dimensionless quantity. It is the ratio of the magnitude of two quantities of like nature, the ratio of the amount of energy in a B.t.u. to the amount of energy in a foot-pound. The ratio of the magnitudes of two like quantities is usually considered a dimensionless number.

Steam turbine manufacturers have long had tables and equations showing the relationship between available energy and theoretical steam spouting velocity. We now see that the one table of theoretical velocities along with one steam chart or Mollier diagram may be used for turbine design or turbine testing at Lynn, Massachusetts, Schenectady, New York, on the Moon, or on the planet Mars.

DEFROSTERS USE 2500 KW

MAMMOTH "defrosters," probably the largest in the World, are being installed at Grand Coulee Dam, Washington, now nearing completion. More than 9 miles of electric heating cable and nearly an acre of steel plates have been placed along the top of the great dam to insure proper winter operation.

The gigantic heating apparatus will prevent ice formation which might freeze tight the 11 huge drum gates along the dam's 1650-foot overflow spillway. The gates control the flow of the Columbia River over the dam.

The gates are designed to perform their task of flow regulation through flotatiton in water. Without "de-icing" the ends of the gates would probably stick to the spillway piers during low temperatures, or any ice bond might form where they rest on their steel seats. Placing plates in the spillway and heating them will prevent this.

The largest of the plates will be 135 ft. long by 8½ ft. wide. There will be 11 of them. There will also be 22 pier plates, one on each end of each gate, which will contain approximately 875 sq. ft. each.

The plates will be heated by induction, that is, the wiring is used to produce heat by setting up an electromagnetic field around itself in steel plates wherever it is strung through them. Electric action by induction causes generation of heat in the plates rather than the wires.

Electricity will be supplied from twenty-two 150 kv-a. transformers—two transformer per drum gate—located in the drum gate gallery immediately underneath gate chambers. In the neighborhood of 2500 kw. might be used for a really tough defrosting job.

LOAD CONDITIONS DETERMINE DESIGN

Five plant designs studied in relation to summer and winter, average and peak loads, dependable service, operating expenses and first cost before final selection was made. Summary of specifications and notes on layout and operation

By GLENN M. LOOMIS
Chief Engineer
Durez Plastics & Chemicals, Inc.
North Tonawanda, N. Y.

PHENOL, or carbolic acid, is a common commercial chemical which has assumed increasing importance of recent years largely because of its basic relation to plastics. It is the most important raw material used by the Durez Plastics & Chemicals, Inc., of North Tonawanda, N. Y., in the production of Durez plastics.

In a new 15 million pound per year plant recently built by the company, synthetic phenol will be produced, under exclusive U. S. rights, by the new Raschig process. By this process less than 0.1 lb. of byproduct results from the production of 1 lb. of phenol. The importance of this is indicated by a statement of a company official that "we would have found ourselves primarily in the chemical business instead of plastics" had older methods[1] of phenol production been employed.

To supply process steam for its recently completed phenol plant, a new steam plant, designed by the company's Engineering Staff, has been built and is in satisfactory operation. This plant was designed to meet the following requirements of the new phenol plant: 1. Required operating pressure to be 190 lb. ga. with a maximum variation of plus or minus 5 lb. 2. An uninterrupted demand not exceeding 46,000 lb. per hr. of steam to be furnished during a period of 50 consecutive weeks each year, except —3, that during this period a peak demand of 55,000 lb. per hr. be furnished for no longer period than 2 wk. and at no more frequent intervals than 3 mo. 4. That 80 per cent of all steam may be condensed and returned to the boilers. 5. That dry and saturated steam containing not more than ½ per cent of moisture be supplied at the boiler nozzles.

It was also considered advisable to have this new boiler installation supply steam for the existing Plastics Plant which requires a maximum of 18,750 lb. per hr., during the winter heating season. This load was carried by an older steam plant consisting of two 250 hp., three drum low head water tube boilers equipped with single retort underfeed stokers. It was contemplated that these units be used for emergency or standby service only after the new plant was finished.

[1]Phenol, discovered by F. Runge in 1834, was first obtained from coal tar but the low yield of from 0.1 to 1 per cent meant a tremendous amount of byproduct if phenol was the desired product. With growing demands synthetic processes were later developed. Benzol sulphonated with sulphuric acid is one method but this has the disadvantage of producing 4 or 5 lb. of byproduct for each pound of phenol. The byproduct can be reduced to 2 to 3 lb. by chlorinating benzene to mono-chlorbenzene which is then converted to phenol by a weak alkaline solution under extremely high pressure.

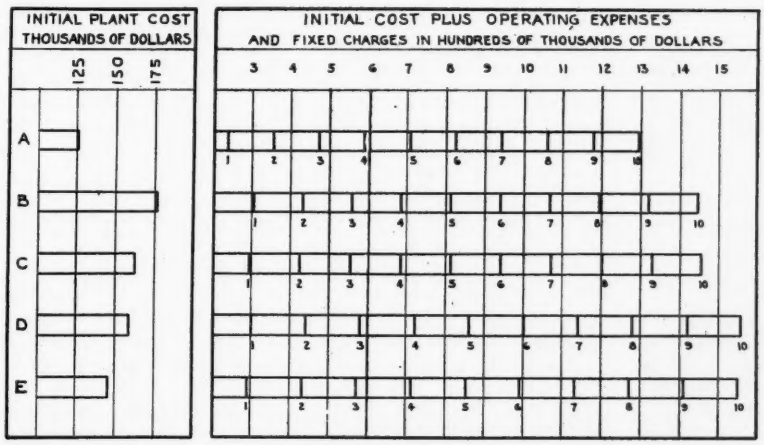


Fig. 1. Summary of investment, fixed and operating costs on five plants. Plant C was finally selected

Studies

Preliminary heat balances were set up to assist in the choice of boiler unit sizes and the number of units required. These are shown by Fig. 1 for the expected summer and winter average load and the extreme winter peak. The winter average load in the phenol plant of 46,000 lb. per hr. was taken as the minimum capacity of boiler units to be always kept in service, while the winter peak of 55,000 lb. per hr. indicated the minimum total installed capacity required for the new phenol plant alone.

An investigation was then made of all the various types of installations considered to be suitable, basing the requirements to be fulfilled in the following order of importance: 1, dependability of operation; 2, cost of operation; 3, installation cost.

Many factors applicable to geographical location influenced the choice, among which were the costs of fuel, cost of transportation of fuel, construction costs, wages of operators and prevailing interest charges.

As fuel oil was available from a process furnace installation, a study was made to determine its desirability as a fuel in the steam plant. It was found to be economical only for use as an emergency fuel and to eliminate the necessity for providing a large dead storage of coal.

From this preliminary investigation five different types of boiler units were considered worthy of more detailed consideration. The cost of each of these installations was estimated together with also the cost of operation based on expected steam requirements.

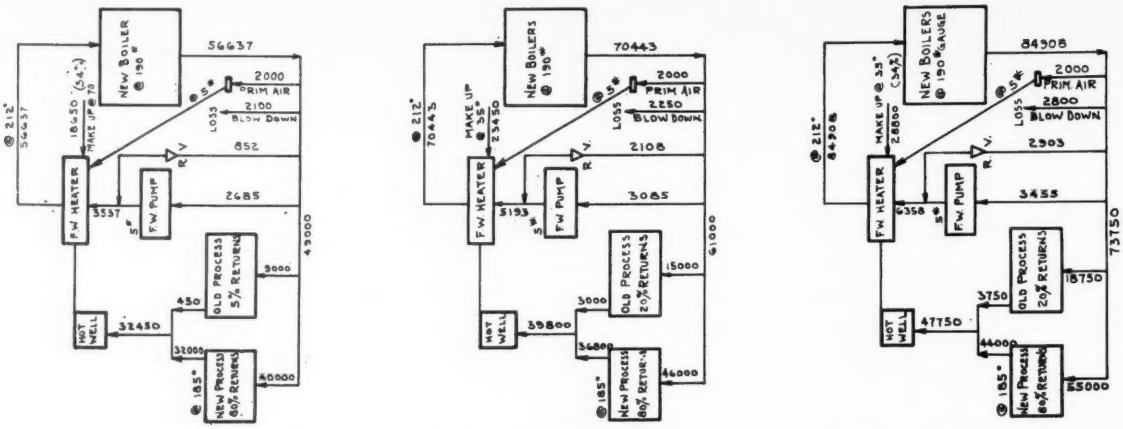


Fig. 2. Heat balances for: left, summer average; center, winter normal; and right, winter peak

To illustrate the method used in selecting between five different proposed types of steam plants, graphs Fig. 2 are used to indicate estimated costs of each type of plant, and in addition yearly operating costs superimposed upon the initial plant cost, thus showing the total expenditure involved in constructing and operating each plant through a ten year period.

Five Types

PLANT A—Consisting of the installation of one 60,000 lb. per hr. two drum boiler with water walls, air heater, induced draft fan, and stub steel stack, complete with all necessary auxiliaries, including a deaerating hot process softener and equipped for oil firing at full rating. As this single unit did not permit inspection or repairs to the boiler during a 50 wk. period, it was considered inadequate to meet the requirements for dependable operation.

PLANT B—Consisting of two similar units of 45,000 lb. per hr. capacity and an expected average efficiency of 84 per cent.

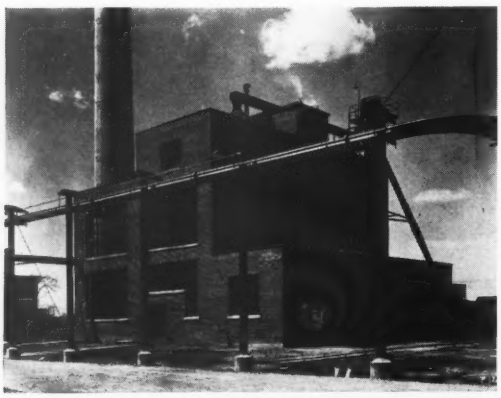


Fig. 3. Exterior view of new plant. The steam line in the foreground comes from the left hand corner of the plant

PLANT C—Consisting of two 45,000 lb. per hr. two drum boilers with pulverizers and equipped for oil firing at full rating, with a concrete chimney 186 ft. high, a deaerating hot process softener and all other necessary auxiliaries (but without induced draft equipment and with steam air heaters for heating and primary air required for the pulverizers. The building to be so constructed that air heaters and induced draft equipment may later be added. The expected average efficiency of this plant to be 79 per cent.

PLANT D—Consisting of three Sterling type boilers each fired with a single retort underfeed stoker without supplementary oil firing equipment or heat recovery equipment but with all necessary auxiliaries including a deaerating hot process softener. Expected average efficiency to be 74 per cent.

PLANT E—Consisting of three, three drum, low head type boilers each fired with a single retort stoker, without supplementary oil firing equipment, but with all necessary auxiliaries including a deaerating hot process softener. Expected average efficiency, 72 per cent.

Plant D offered no advantages except that of flexibility of operation due to the three boiler units. Plant E was low in first cost but was found to be more expensive at the end of 3 yr. operation than either Plant B or Plant C. Plant B was found more expensive to build than Plant C but higher efficiency offset the greater initial cost at the end of 4 yr. operation.

Plant C, however, was chosen for the following reasons: 1. A comparatively high chimney was considered imperative to properly disperse fly ash. 2. The heat balances indicated all motor driven equipment except for one turbine driven boiler feed pump and with natural draft obtainable from the chimney and with oil firing, a total of 40,000 lb. per hr. could be produced with both boilers in event of a power failure. 3. Lower initial cost also influenced the decision. 4. That induced draft and heat recovery equipment could be added when desired with only slight changes.

Specifications as below were written for the boiler and pulverizer units with the particular objective of providing full rated capacity with any properly sized coal from Pennsylvania and West Virginia districts as received on the railroad siding under normal weather conditions.

Specifications

Boilers are to be of the integral type design, provided with water walls and fired with pulverized fuel. The burners are to be equipped to handle full load while firing with oil.

a. Design pressure 250 lb. per sq. in. ga.

b. Operating pressure 190 lb. per sq. in. ga.

c. Maximum continuous capacity 45,000 lb. of steam per hr. with feed water at 212 deg. F. and using bituminous coal of 12,500 B.t.u. as fired with an ash softening temperature of 2100 deg. F.

d. A guaranteed efficiency throughout a 24 hr. continuous test of 80 per cent; delivering 45,000 lb. of steam per hour at the boiler

nozzle at 190 lb. ga. with 212 deg. F. feed water using the fuel shown by Table I.

e. That the quality of steam from the nozzle at 45,000 lb. per hr. be such that it contains not over ½ per cent moisture with a boiler water concentration of not less than 2500 p.p.m. total solids.

f. That a guaranteed draft loss through the boiler passes at 80 per cent efficiency and at maximum rating be stated.

g. That the draft required at boiler outlet be stated.

h. That the total heating surface of boiler and water walls be stated.

Pulverizers and Burners

a. That the pulverizers and burners to be furnished have capacity sufficient to supply properly conditioned fuel to each boiler when: delivering 45,000 lb. of steam per hr. at 80 per cent efficiency; and pulverizing a fuel with a grindability of 54 Hardgrove, having a B.t.u. content of 12,500 as fired, and containing 2 per cent residual moisture, but capable of handling 8 per cent additional air dry moisture.

b. That the maximum guaranteed capacity of the pulverizer be stated, based on requirements as outlined in the preceding paragraph.

c. That the guaranteed power consumption per ton of fuel, of mill, fan and feeder be stated, based on fuel as specified in paragraph a and upon operation at rated maximum boiler capacity.

d. That a guaranteed minimum rating for continuous operation be stated on the proposal. This to be construed as the lowest continuous rating that will give satisfactory operation of the unit as a whole.

e. Pulverizer, fan and feeder to be driven by 440 v., 25 cy., 3 ph. induction motors of the air cooled, totally enclosed type.

Plant Layout

Considerable care was given to the design of this plant to secure a convenient arrangement of equipment and control points. While the plant was designed for two man operation, it was expected that one man unload coal and remove fly ash, which would leave during those periods but one operator inside the building. Also, in event of failure of automatic controls, the convenient placement of manual controls was considered essential.

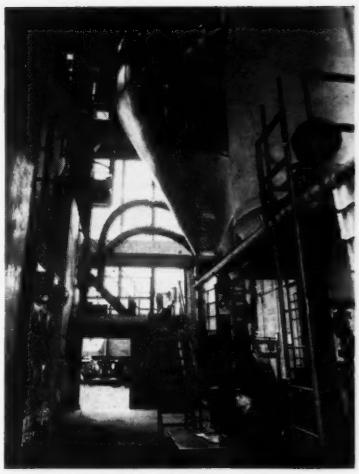


Fig. 5. Interior views looking from Boiler No. 6 toward No. 5. The control panel is between the two boilers, the operator is directly below the sedimentation tank and partially obstructs the view of No. 5 pulverizer

Quick access to burners was provided for and all equipment needing frequent attention by the operator was located as close as possible around a central point where a desk and chair was placed for the head operator. The building was designed around the equipment and purposely made small so that as few steps as possible were required by the operator to handle his equipment.

All essential valves, access doors, boiler drums and gage glasses are accessible either by stairways, ladders or platforms and all moving equipment except for condensate pumps was located on the firing floor where frequent inspection could easily be made. Full automatic control of the boiler units was considered necessary as close control of steam pressure with fluctuating loads was required.

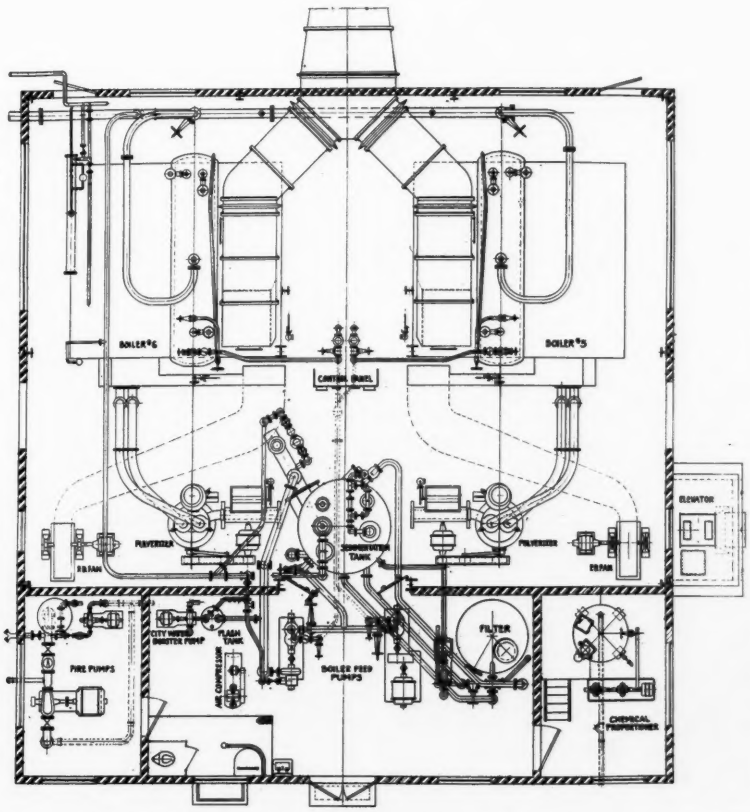


Fig. 4. Plan of the boiler room, showing the arrangement of the two boilers and auxiliary equipment

Table I. Data on the Pittsburgh Coal Co. Alleghany County Coal from Panhandle District which was used as the specification reference. Size 1¼ in. nut and slack (through 1¼ in. ring)

Moisture, total, in %	3.7
Moisture, inherent, in %	1.5
Volatile, in %	34.0
Fixed carbon, in %	51.0
Ash, in %	11.3
Sulphur, in %	2.2
B.t.u. per lb., dry	13,150
B.t.u. per lb. as fired	12,650
Ash softening temp., deg. F.	2300
Grindability, Hardgrove	60

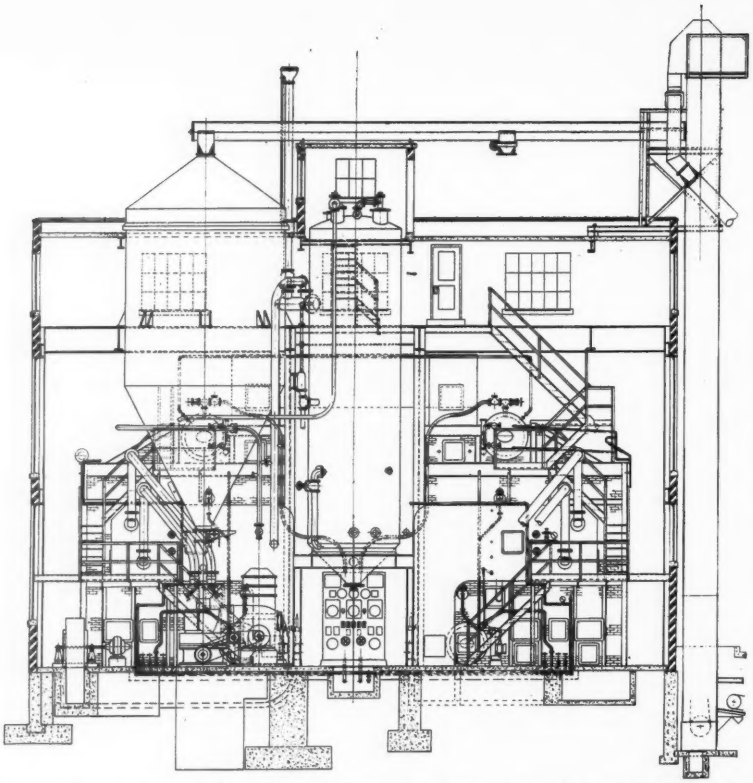


Fig. 5. Cross section of the plant. This section is taken in front of the pulverizer of the left hand boiler. (No. 6 of Fig. 4) and between the pulverizer and boiler on the right hand side

The plant was designed for manual removal of fly ash with provision however, for the later addition of an ash handling system should this prove advisable. Coal handling equipment was designed to unload a 50 t. car in 2 hr.: from a track hopper; over a belt feeder and magnetic separator; through a chain and bucket elevator to a screw conveyor located on the building roof delivering to either of two 90 t. coal hoppers located directly over the pulverizers; or delivering, if desired, to ground storage. Considerable stress was placed on rugged design of this equipment to obviate plant shut downs due to breakage and excessive wear.

A hot process lime and soda softening system was selected for feedwater treatment. The capacity of this system was specified at 16,000 gal. per hr., of which 6,000 gal. was to be raw makeup water.

Condensed steam from process is returned to a 700 gal. tank in a small basement in the steam plant from which it is pumped either with a turbine driven or a motor driven centrifugal pump to a condensate compartment in the deaerating softener. Two boiler feed pumps, one motor driven, the other turbine driven, supply conditioned feedwater to the boilers, each pump being of sufficient capacity to supply both boilers.

As city water pressure is at times insufficient to supply make-up water at the elevation required, a centrifugal pump automatically operated from a float switch in the softener was installed.

Operation

The plant started operation early in February, 1940. Up to the first of June it operated at between 30,000 and 45,000 lb. of steam per hr. The load since then has increased to between 45,000 and 55,000 lb. per hr.

As this load could be carried on one boiler unit, it was no problem to make necessary adjustments to the controls and equipment while operating. After some experimenting the maximum output was brought up to 48,000 lb. per hr. on each boiler with the coal specified.

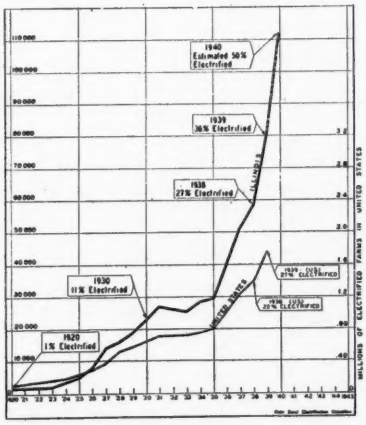
To the hot lime and soda ash, sodium sulphate has been added. It was found necessary to do this to bring up the sulphate-carbonate ratio from 1:1 to 2:1.

Since operation started, total solids have been carried from 2000 to 2500 p.p.m. and the hardness has ranged from 0.5 to 0.7 g.p.g. With this treatment and without phosphate, only a light, loose scale which comes off very easily when the boilers are washed down, has been experienced. However, due to the type of make up water used, a very careful check must be kept on water treatment.

RURAL ELECTRIFICATION IN ILLINOIS

DATA collected by the state Rural Electrification Committee of Illinois indicates exceptionally rapid progress in rural electrification. At the present rate of construction it is estimated that 50 per cent of Illinois' 225,000 farms should be electrified by the end of 1940.

In 1923 only one per cent of the Illinois farms were electrified. Thirteen years later this had increased to 15 per cent. Thereafter the gain was much more rapid. During 1939 electrified farms increased from 27 to 36 per cent in Illinois compared with an increase of from 22 to 27 per cent for the United States as a whole.



Increase in rural electrification in Illinois since 1920

SUPERCHARGING HIGH SPEED DIESELS

Drawing on his personal experience as an engine designer for almost 20 yr. and with no attempt to generalize, the author outlined at the last annual meeting of the S. A. E. the course of high speed engine design with particular attention to the research program of his own company, reasons for continuation with the four stroke cycle, development problems and design considerations. The portions abstracted cover only the engine performance of certain units to show the effect of supercharging

By Robert P. Ramsey
Chief Engineer
The National Supply Co.
Philadelphia, Pa.

THERE IS so little published data available on the subject of high speed, four cycle supercharging that it is impossible to cover all of the points analytically but certain conclusive tests and developments which have been actually accomplished should serve as proof of the possibilities.

During 1922 and 1923 a 9 by 12 in., 4 cycle Diesel engine used for logging on the Pacific Coast weighed 15,000 lb., developed 100 hp. and turned at 325 r.p.m., that time was considered to be high speed. What is thought to be the first substantial step towards the automatic type or mobile high speed Diesel engine in this country probably was embodied in a 6½ by 8½ in. excavator type Diesel engine made by a Pacific Coast manufacturer and quite widely used in 1926.

That engine weighed approximately 6500 lb. and developed about 60 hp. at a speed of 550 r.p.m.

About 650 r.p.m. seemed to be about the maximum speed allowable for that particular design of common rail injection engine, although I built an engine of about that same size and weight which did run successfully up to 900 r.p.m. using a combination of common rail and synchronized impulse pump injection. However, 80 lb. b.m.e.p. at 900 r.p.m. on an engine of 6 by 8 in. cylinder size and weighing around 50 lb. per hp. was then considered too fast and too light to ever find much success in Diesel fields.

In 1927 an engine of about 50-hp. per cylinder turning at a speed of 900 r.p.m. was offered to the market. Also an American company, at about this time, started to build a 6 by 8 in. engine turning at 1000 r.p.m., weighing 2700 lb. and developing about 92 hp. European truck manufacturers sponsored some engines about that time, which actually operated at the high speed of 1200 to 1500 r.p.m. and would show 75 or 80 lb. b.m.e.p. without excessive smoking but the American market was more conservative.

When 1000 R. P. M. Was High

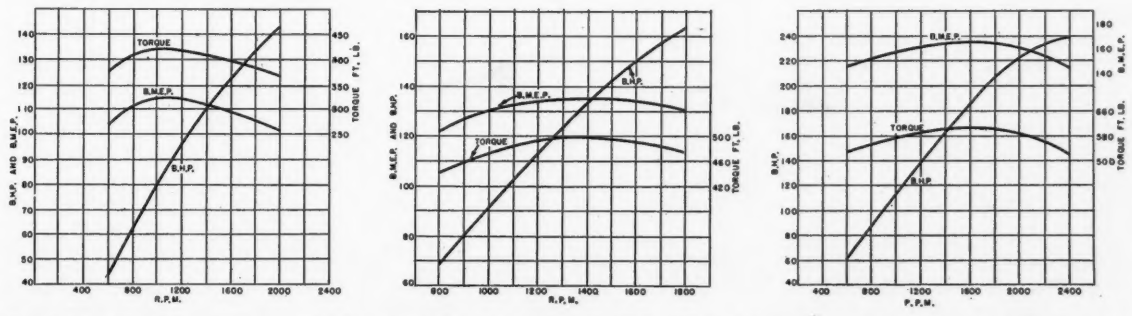
Early in 1930 I became associated with the company mentioned. By that time the 1000 r.p.m. engine was fairly successful. It weighed 25 to 30 lb. per hp. but the fuel pump for a 6 cylinder 6 by 8 in. engine weighed over 1000 lb. That is material for some thought. It has only been 10 yr. since that engine was representative of light weight and high speed in the industry while today a fuel pump for an engine of that size weighs only about 35 lb.

Subsequently the design of a 900 cu. in., 6 cylinder 5¼ by 7 in. engine was carried through, about the first all American designed Diesel of that class which attained a speed of 1200 r.p.m. to 1500 r.p.m. with 75 to 80 lb. b.m.e.p. and a weight of 25 to 30 lb. per hp. This engine was a step forward and it proved to be successful at a speed of 1200 r.p.m. or more and it was a reliable simple design under a loading of about 75 lb. b.m.e.p.

During the period between 1930 and 1934, I had the responsibility of designing and developing several automotive and marine engines. One was a 6 cyl., 415 cu. in. engine of 4 in. by 5½ in. Another was a 186 cu. in. 4 cyl. design, 3⅝ by 4½ in., weighed 900 lb. and at a speed of 2000 r.p.m. developed 40 to 50 hp. These engines were later used by the Navy.

By 1934 a New Line Was Started

In 1934 things were becoming more stabilized. Each manufac-



Figs. 1, 2 and 3. Performance curves for three 6 cyl. Superior engines all 4½ by 5¾ in. with a displacement of 549 cu. in. The first is an early model AA-6 unsupercharged stripped engine. The second is an early development of the Model SMA-6 supercharged. The third is the latest development of the Model SMA-6 supercharged with full marine equipment including reversing gears, generator, pumps and supercharger

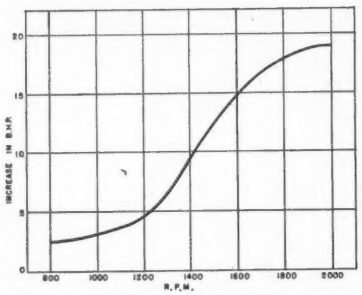


Fig. 4. Curve showing the effect of the supercharger air cooler on engine performance of the Model SMA-6

turer had his problems fairly well under control. In the beginning of that year, I became associated with The National Supply Co., who had decided in their Philadelphia Plant, formerly the old Otto Engine Works, to develop a complete line of high performance Diesel engines in the smaller sizes. We elected to settle on a cylinder size of 4½ by 5¾ in., producing this in multiple of 2 cylinders up to and including a straight 8, with complete interchangeability of parts throughout.

Since 1935 this engine has demonstrated its ability as a heavy duty truck and bus power plant. However, our company has never entered the truck field actively and has concentrated largely in the marine and industrial field for production and merchandising reasons. The completely equipped automotive model weighs 2000 lb. The engine develops a peak 142 hp. at a speed of 2000 r.p.m., weight of 14 lb. per b.hp., 102 lb. b.m.e.p. A performance curve is shown, Fig. 1.

Identically this same engine has been used in nearly every type of marine application since it was designed for marine, automotive and industrial usage. The marine type is rated at 90 lb. b.m.e.p. and turns at 1600 to 1800 r.p.m. In marine usage the speed is usually quite constant and actually from our test figures the marine service requires more of an engine than is demanded by the truck type of application. A compression ratio of 11.8 to 1 is standard in this engine and this results in a commercial peak cylinder pressure of 750 lb. per sq. in. at 90 lb. b.m.e.p. and at 1600 r.p.m.

In 1936 our laboratory set up a research program devoted to an exploration of the possibilities of higher engine outputs and lighter weight. Our analysis indicated that the four cycle supercharging program should be followed in our development work and we elected to use our existing basic design of 4½ by 5¾ in. engine increasing the speed and output. The question of how high an output could be taken out of a four cycle supercharged engine, commercially and with due regard to economy, life and first cost was a research matter.

In the gasoline engine of presumptively correct design a high degree of supercharing would indicate a heavier structure approaching the Diesel. In the Diesel engine the more practical idea is to use the supercharger as a first stage compressor throughout the whole engine speed range increasing the horsepower and torque of a given engine. The engine compression ratio has to be considered in order that the overall ratio of the two stages results in proper compression temperature.

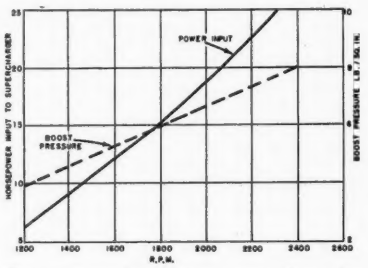


Fig. 5. Supercharger horsepower absorption curve and boost pressures for the Model SMA-6 6 cyl. engine

A 50 per cent increase in b.m.e.p. need mean only one or two per cent increase in engine rate of wear as the indicator card is merely widened and not increased in pressure. A few additional crank degrees of sustained maximum pressure result in a great increase of power but the percentage of wear increase is only a very small amount throughout the 720 deg. of the four cycles.

After about one year's experimentation in the laboratory, an engine was approved and operated for 2500 hr. under the then full load conditions of 120 lb., b.m.e.p. at 1800 r.p.m., an increase of 33 per cent in m.e.p. and 12 per cent in engine speed above a standard unsupercharged marine engine. The maximum combustion pressure did not exceed 750 lb. and the exhaust temperature maximum amounted to 850 deg. F. Fuel economy at 120 lb. b.m.e.p. was exactly the same as in a standard engine operating at 90 lb. b.m.e.p.

It should be pointed out here that this same engine will develop a maximum of 110 lb. brake mean effective pressure without a supercharger but with higher fuel consumption and higher exhaust temperatures accompanied by higher maximum combustion pressures. It is considered that 90 lb. b.m.e.p. is as high as the normal engine should be operated without supercharging except for short periods.

Loading on the engine itself at a supercharged output of 120 lb. b.m.e.p. was equivalent to the same loading on the engine unsupercharged at 90 lb. b.m.e.p., although later it proved that 160 lb. b.m.e.p. supercharged can be made to produce the same loading as 90 lb. on a standard engine.

After the completion of dynamometer testing this engine was placed in a boat operated by our Experimental Department and was run constantly at 1800 r.p.m. under ocean conditions with all adjustments on the engine sealed. The boat covered 40,000 mi. before inspection during which time it was untouched for any adjustment purposes. When the engine was taken down, it was in perfect condition. Figure 2 shows output curves on this engine.

At this point it was decided to abandon the vane type blower only because it was made in England and not available in the United States. The Roots type machine was adopted in favor of the vane design for no other reason than that several American manufacturers were interested in developing commercial Roots type blowers. It was decided that since the initial program of tests in the development of our supercharged 4 cycle engine had been satisfactory, we would endeavor to carry

(Continued on Page 122)

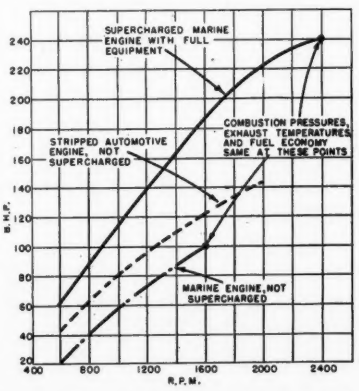
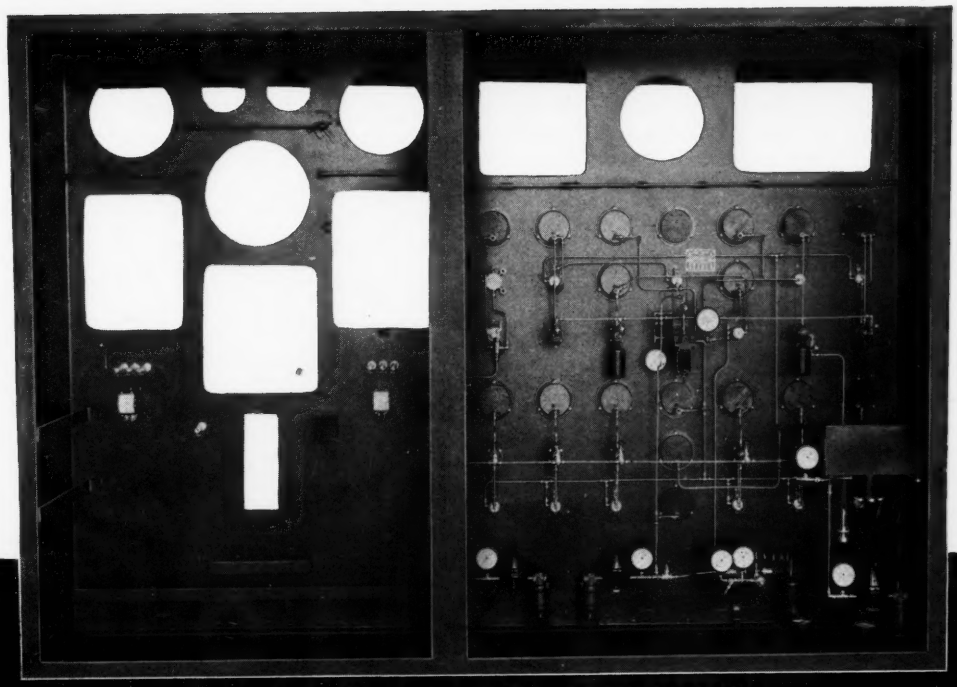

SUPERCHARGED MARINE ENGINE WITH FULL EQUIPMENT
COMBUSTION PRESSURES, EXHAUST TEMPERATURES AND FUEL ECONOMY SAME AT THESE POINTS
STRIPPED AUTOMOTIVE ENGINE, NOT SUPERCHARGED
MARINE ENGINE, NOT SUPERCHARGED
B.H.P.
R.P.M.

Fig. 6. Comparative power curves for the 6 cyl. engine supercharged and not supercharged



Rear view of a Hagan control panel before instruments are mounted.

Look "under the hood" when you buy *Combustion Control*

With Hagan it's Engineering that Counts!

YOU don't trade in a combustion control system every year or two, so look "under the hood" when you do buy one. Hagan control panels grace the boiler rooms of leading power plants everywhere, but it is the engineering craftsmanship behind those panels which maintains the Hagan reputation for consistent, reliable performance under severest operating conditions.

Hagan Control is precisely engineered from master sender to the tiniest link in the system. Many original Hagan installations, now more than 20 years old, are still operating efficiently. The same basic principles on which they were constructed are utilized in the newest, most advanced Hagan systems —proof of the engineering soundness that characterizes all Hagan equipment.

When you buy a combustion control system, therefore, look "under the hood." Investigate the workmanship *behind* the panel board, the operation and construction of the equipment to be used and buy the system you can rely upon, not for a year or two, but for a decade or more. Yes, look "under the hood" and then buy Hagan!

HAGAN CORPORATION · 300 ROSS STREET · PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

2000 Lb. Topping Turbine at Montaup

By ELMER SMITH
District Turbine Specialist
General Electric Company

THE PRESENT generating station of the Montaup Electric Company at Somerset, Mass., contains two General Electric Co. single casing 1800 r.p.m. units with direct connected house service generators. The older unit is rated 36,000 kw. and the newer unit 40,000 kw., making a total of 76,000.

They operate at present with 365 lb. gage pressure at the throttle and both units are fitted with extraction heaters.

The station runs with a very good load factor and has shown a performance of 14,350 B.t.u.

Recently an order was placed with the General Electric Company for a topping turbine suitable for 25,000 kw. continuous output at 87½ per cent P. F. This unit will be served by the first forced circulation boiler to be installed in a public utility in this country and which will be supplied by the Combustion Engineering Company. The boiler will operate at approximately 2000 lb. pressure and the turbine at 1800 lb. gage pressure and 950 deg. F.T.T. at its throttle.

The exhaust from the topping turbine at about 400 lb. gage pressure will go to boiler reheaters, thence into the present station mains and to the existing turbine throttles at 365 lb. gage and 750 deg. F.T.T. It is hoped that under ideal load conditions after the installation of the topping turbine, that the station rate will be reduced to 10,500 B.t.u. per net kilowatt of station sent out or perhaps slightly better.

The boiler feed problem on such a station becomes interesting because of the difficulty of obtaining standby service in the usual way with a pump under pressure and driven by a steam turbine with solenoid operated throttle valve. This arrangement is easy on low pressure outfits, but with around 2100 lb. on the pump shaft packing, this arrangement becomes substantially impossible. This is for the reason that a pump shaft packing that will not leak when standing still at this pressure, could not reasonably be expeceted to come up to about 3600 revolutions in a few seconds with safety.

For this reason the Stone & Webster engineers, collaborating with the Ingersoll Rand engineers, devised a scheme which has novel features. They propose to run two turbine driven boiler feed pumps practically all the time, each one handling up to about 325,000 lb. of water per hour and requiring around 1050 hp. Each outfit, however, would be so arranged that if one of the running units failed to function, the other unit would take up the entire load delivering approximately 650,000 lb. maximum per hour, and at 4000 revolutions, requiring about 2200 b.h.p. from the boiler feed turbine.

The station heat balance was such that substantially 70 per cent Rankine efficiency was necessary on these boiler feed turbines under regular load conditions. These requirements were met by multistage General Electric sectionalized valve gear units, three of which of 2200 hp. each will be supplied.

A further interesting feature is that since these boiler feed turbines are such respectable outfits, they will be placed at the same floor level as the 25,000 kw. topping turbine so as to get the same operating attention as the main unit.

It is hoped that the plant will be in service late in the summer of 1941.

Clearing the Right-of-Way for the Bonneville Power Lines

(Continued from Page 87)

The second major section which will serve the area along the coast, the Vancouver-Aberdeen Line, starts at the substation at Vancouver and proceeds northwesterly to Aberdeen in Grays Harbor County, a distance of approximately 127 miles.

A third line is being cleared from Chehalis to Renton, a distance of approximately 70 miles. This line which is tied in with the substation at Vancouver will eventually be extended northeast to meet the Grand Coulee project thus completing a huge power loop for the State of Washington. From this loop other lines will be extended as the power requirements for home, industry and irrigation pumping increase and as the completed dams extend their influence.

The major portion of the clearing of the Bonneville-Aberdeen Line, and on the Bonneville-Yakima-Grand Coulee Line are almost completed and the towers and power lines are being erected under contract. Work is now progressing on the 70-mile Chehalis-Renton Line.

Over more than 280 miles of the transmission line, the men worked in extremely mountainous terrain, necessitating considerable manual labor. Hand logging consisted of brushing, falling, bucking, piling, grubbing and burning the unsalable timber. Clearing operations were especially difficult owing to the large amount of old growth, snags and windfalls encountered. Some of the timber which had to be felled in the clearing operation were six feet in diameter.

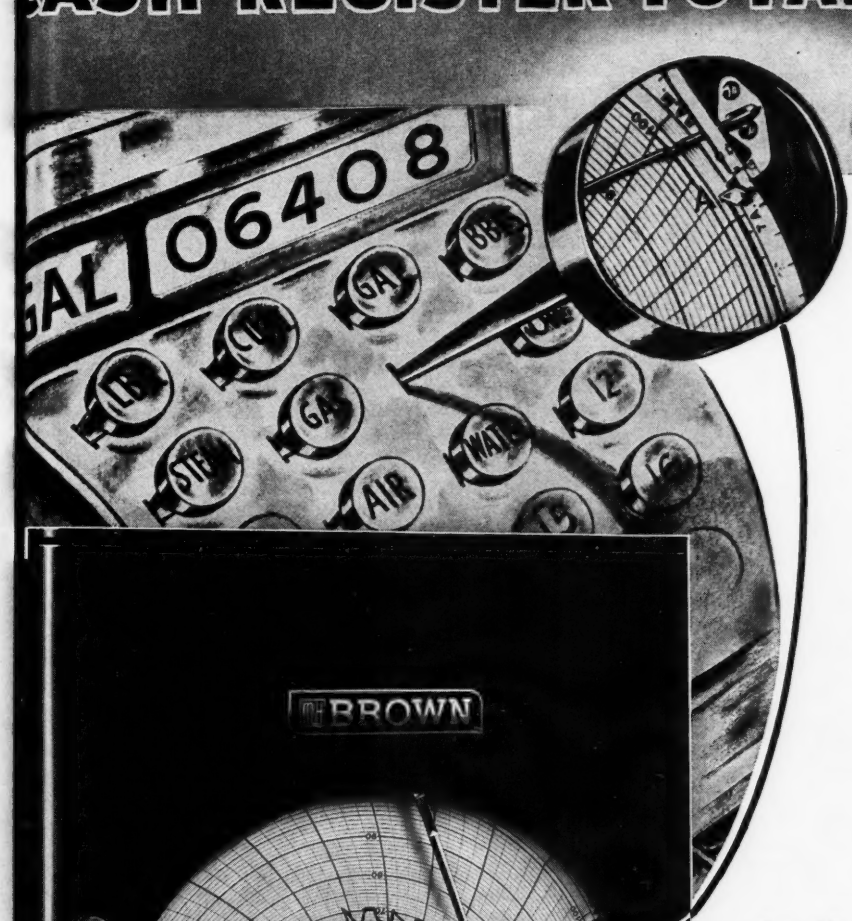
Machines and equipment also have played an important role on this job. Machine logging was done by "cats" equipped with the necessary logging tackle. Burning operations were extremely hazardous, and added precautions were taken to prevent fires from jumping the right-of-way and burning valuable timber along the line.

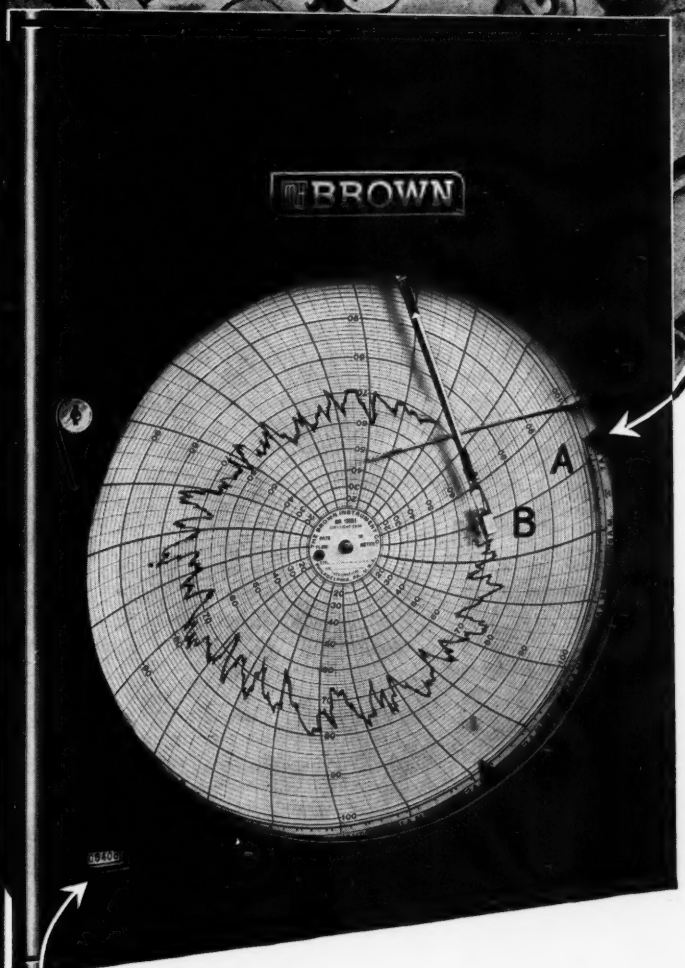
To accommodate crews, working in isolated sections where it was necessary to concentrate men in considerable numbers to clear right-of-way areas through mountainous and sparsely settled territory, it was necessary to establish special work camps. On the Bonneville-Yakima-Grand Coulee Line three of these camps were set up.

More than 2,500 men were employed throughout the entire system of right-of-way clearing at the peak of operations. At the present time some 500 men are assigned to the work now in progress.

A new project, already drawn up and now waiting approval, would continue the line from Renton across the Cascade Range to the Columbia River near Rock Island, a short distance from Coulee Dam.

TOTALS FLOW AS A CASH REGISTER TOTALS DOLLARS





06408

Steam IS money. Wasting steam boosts overhead—eats up income—shrinks profits. Steam accounting is serious business—it needs business methods.

As a modern cash register guards a storekeeper's dollars—producing a printed record of each transaction—so flow meters should guard your power and process steam.

With Brown Flow Meters measuring the flow of fluids for power, heating and processing, you are completely protected—because

The Brown Automatic Recording Planimeter Pen, "A", making the marginal record shown on the chart pictured supplies the PROOF that a definite number of pounds of steam, gallons of water, cubic feet of gas, or barrels of oil, were delivered, utilized—or wasted.

This is a special, patented feature of the greatest value to flow meter users. Reference to the automatic planimeter pen record on chart rim assists you to distribute departmental or process loads more uniformly over the working day, effecting substantial fuel savings not only in the boiler room but in every department or unit where steam is used.

In addition, Brown Flow Meters offer you other advantages such as:

Six inter-related range tubes with inter-related direct reading charts.

Meter Bodies for working pressures up to 2500 lbs.

Integrator dial—easy to read—insures highly accurate totalizing at all rates of flow from 0-100%.

Universal case permits any style panel mounting — flush on panel, front-of-board or on wall.

Indicating, Recording and Controlling models—Electrical, Mechanical and Area types for all applications.

Get all the facts about Brown Flow Meters. Features are fully explained in Catalog No. 2007. Send for your copy. THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Co., 4491 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street — Amsterdam-C Holland: Wijdesteeg 4—England: Wadsworth Road, Perivale, Middesex—Stockholm, Sweden: Nybrokajen 7.

"A" This automatic planimeter pen record shows steam flow in volume units and the time at which it was produced or used in any part of the 24 hour period, enabling you to easily analyze steam production and distribution.
"B" This record line shows rate of flow and enables the operators to maintain the most efficient boiler operation, thus effecting substantial fuel savings.

BROWN Flow Meters

Accurate Measurement with Simplicity

MECHANICAL ENGINEERS In 61st Annual Meeting

Hotel Astor in New York Was Scene of A.S.M.E. Activities, December 2 to 6, Too Large for Facilities at Engineering Building. National Defense Given Right of Way.

DIRECTING the thought of engineers to the idea that better living and greater industrial progress is possible through engineering, the program of the sixty-first annual meeting of the American Society of Mechanical Engineers, held in New York City December 2 to 6, was filled with papers and addresses that were inspiring to engineers who have faith that their profession is opening the road to fields that have scarcely been explored. To such interests as fuels, machine-shop practice, steam power, railroads, textiles, process industries, metals, heat transfer, materials handling, hydraulics and applied mechanics, long recognized as subjects with which engineers are best equipped to deal, necessity has demanded that this profession must now increasingly broaden its interest in management, employment problems, social conditions, investments, and, most emphatically, the program of National Defense.

So great was the demand for the presentation of papers and reports on investigations of subjects of special interest that the Society was compelled to seek more extensive accommodations than are available in the Engineering Building. By holding all sessions, committee meetings and social functions in the Hotel Astor, those in attendance found the arrangements convenient and the club-like atmosphere an added pleasure. Nearly 2,600 registered for this meeting, the largest since 1930.

Marking the social highlight of the meeting was the annual dinner at which time national awards were presented, honorary membership bestowed, President Warren H. McBryde reported on the progress of the Society and Past President William L. Batt delivered an inspiring address on the subject "As Through a Glass, Darkly" which dealt with National Defense, its present and future aspect. More than a thousand engineers and guests attended this function.

President McBryde reporting on recent progress of the Society

At the closing session of the meeting on Friday morning the new president, William A. Hanley and other new officers were installed. Mr. Hanley is a director and head of the engineering division of Eli Lilly & Co., Indianapolis, Ind. The three new vice-presidents are: Samuel B. Earle of Clemson A. & M. College, Clemson, S. C.; Frank H. Prouty of the Industrial Appraisal Commission, Denver, Colo.; and Edwin B. Ricketts, mechanical engineer with the Consolidated Edison Co. of New York, Inc. The new managers are: Huber O. Croft, University of Iowa; Paul B. Eaton, Lafayette College; and George E. Hulse,

In the receiving line, Secretary C. E. Davies, President Warren H. McBryde, Miss McBryde, Wm. A. Hanley, Mrs. Hanley

Safety Car Heating and Lighting Co., New Haven, Conn.

Boilers and Furnaces

Interest at the power and fuels sessions centered around the design of water tube boilers, particularly as related to the furnace arrangement and settings, their operating characteristics, water circulation and problems encountered in the burning of coal. The results secured from boilers of the twin-furnace design were reported. These boilers were described by John Blizard and A. C. Foster as of three types, boilers with two furnaces with separate means of firing, separated by a water wall, which operate in parallel. In the first type the furnaces differ in that in only one of them is placed a radiant superheater. In addition to the radiant superheater, there is a convection superheater over which the gases from both furnaces pass. In the second type, a superheater is placed in one furnace but the gases from the superheater furnace pass through the furnace in which there is no superheater. No convection superheater is provided. When a separate sup-

(Continued on Page 104)

TACKLE 'EM LOW!

THE football player who stops them cold is the one who stays close to the ground. And the same system gets results in other fields.

Take for example the lubricants that protect your machinery. Shell men have thrown friction for losses time and again by keeping close to the ground—*your* ground.

They have worked with Diesels and steam turbines, machine tools and textile looms, fishing vessels and steel mills . . . with equipment just like yours, throughout the years. The right lubricant for each job means lowered costs and longer life. And to be sure of the right lubricant, Shell men have found no substitute for first-hand study of machines-on-the-job.

• • •

However, you're not nearly so interested in hearing case histories of the money they've saved other plants as in seeing how much money they can save in yours. ***The first step toward finding out is to call in your Shell man today.***

SHELL

SHELL INDUSTRIAL LUBRICANTS

(Continued from Page 102)

ply of saturated steam is required, the steam may be taken directly from the steam drum. In the third type, the gases from the two furnaces pass over a convection superheater. No radiant superheater is provided.

Demonstrated advantages of these twin-furnace boilers comprise a lower furnace exit-gas temperature than with a single-

Toastmaster's view of dinner guests

furnace type, and the ability to control the final temperature of the steam over a wide range of steaming by suitable adjustment of the rate of firing in both furnaces.

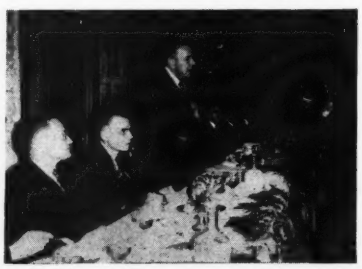
Steel casings for boiler settings are not new. Experience with them, however, has in many cases led to failure of the refractory with the result that their use heretofore has been confined to small boilers where the furnace temperatures are comparatively low. Advent of the water-wall furnace has brought about a renewal of efforts to apply steel casings to boilers. One of the advocates of this type of setting, who has had success in applying them to large boilers, is Max H. Kuhner. His studies and experiences have led him to the following conclusions:

A completely air-tight steel encased setting presents attractive, economical advantages; absence of air leaks into the setting results in power saving for the induced draft fan, in the maintenance of high efficiency and in the elimination of the possibility of reduced steaming capacity of the unit caused by overloaded induced draft fan; the strong steel jacket covering the entire unit is the safest insurance against damage from internal dust and gas explosions; maintenance expense of a correctly constructed steel casing is practically nil and consists only of an occasional painting; lower total weight of this type of setting reduces cost of foundation work and structural steel; under favorable conditions an entirely air-tight and weather proof steel shell covering a steam generating unit eliminates the necessity of a boiler house; the lower weight and greater resilience of a steel encased insulated setting make it most suitable in locations where seismic disturbances are anticipated.

Boiler Water Circulation

That the elements of boiler and furnace design control the natural circulation of water in a boiler was brought out by John Van Brunt, who analyzed the problems involved and presented calculations that indicate that high-pressure, high-capacity boilers can be designed with a comfortable margin for overloads when only natural circulation is depended upon. In the discussion, operators brought out the fact that tube conditions change rapidly after a boiler is put into service so that considerable margin of safety must be allowed in the design calculations.

Space limitations in many instances prevent employment of natural circulation methods in the design of a boiler to be operated at high heat transfer rates. At least so thought S. L. G. Knox, who designed an entirely new type of forced circulation boiler in which an impeller placed longitudinally in a lower drum exerts a pumping action which results in a uniform and rapid cir-



Student delegates addressed by Mr. McBryde at luncheon where George A. Hawkins, second from left, was presented the certificate of award of Pi Tau Sigma Medal for achievements in high-pressure steam research

culation through a number of riser tubes which comprise the walls of a combustion chamber. The furnace volume is only 5.67 cu. ft. but during a test the heat release using oil as fuel was pushed to an average of 400,000 B.t.u. per cu. ft. per hr. with smokeless combustion. Steam pressure generated was 500 lb. per sq. in. and at full capacity the rate of generation was 1186 lb. per hr. while the efficiency secured was 81.3 per cent.

This boiler was developed primarily to supply steam for a new type of steam engine which Mr. Knox designed for use where an efficient, reversing unit is required, such as for hoisting or excavating purposes. The engine, whose performance was described by J. I. Yellott, has a maximum capacity of 90 hp. and is a high-speed, compound reversible unit with uniflow exhaust. The inlet valves are of the piston type and the engine has the unique feature that each valve supplies a particular cylinder when the engine is running forward, but a different cylinder when the engine is reversed. Test results reported showed a steam rate of 14.6 lb. per b.hp-hr. with an initial steam condition of 595 lb. pressure 750 deg. F. while the back pressure was 15.2 lb.

Boiler room operation control so as to maintain continuous heat balance is an ideal attempted in all well managed fuel burning power plants. At the Hudson Avenue Station, it was pointed out by Benjamin S. Murphy, an attempt is made to synchronize such apparently unrelated factors as scheduling boilers for cleaning, turbine outages, and personnel as well as incremental boiler loading and automatic control. In regard to the boilers, he expects that they will give the maximum expected output, whenever called upon and give it economically.

The term underfeed stoking describes very definitely the method of getting the coal to the fuel bed. Beyond that stage, engineers have found that many complicated factors develop in the burning process which place limitation on the capacities obtainable and the quality of the usable coal. It was to solve the problem of extending these limitations that Martin A. Mayers conducted experiments with underfeed multiple-retort stokers, studying the flow through the fuel bed of the fuel and ashy refuse; the gases, such as air and products of combustion; and heat, especially that portion which recirculates within the bed and leads to preparation and ignition of the fuel.

From the data compiled, the author developed the features which he believed would be possessed by a stoker designed for much higher duty than any now in existence and analyzed the possible results to be obtained. These

(Continued on Page 106)

DUREZ the modern plastic selects the COCHRANE SOFTENER

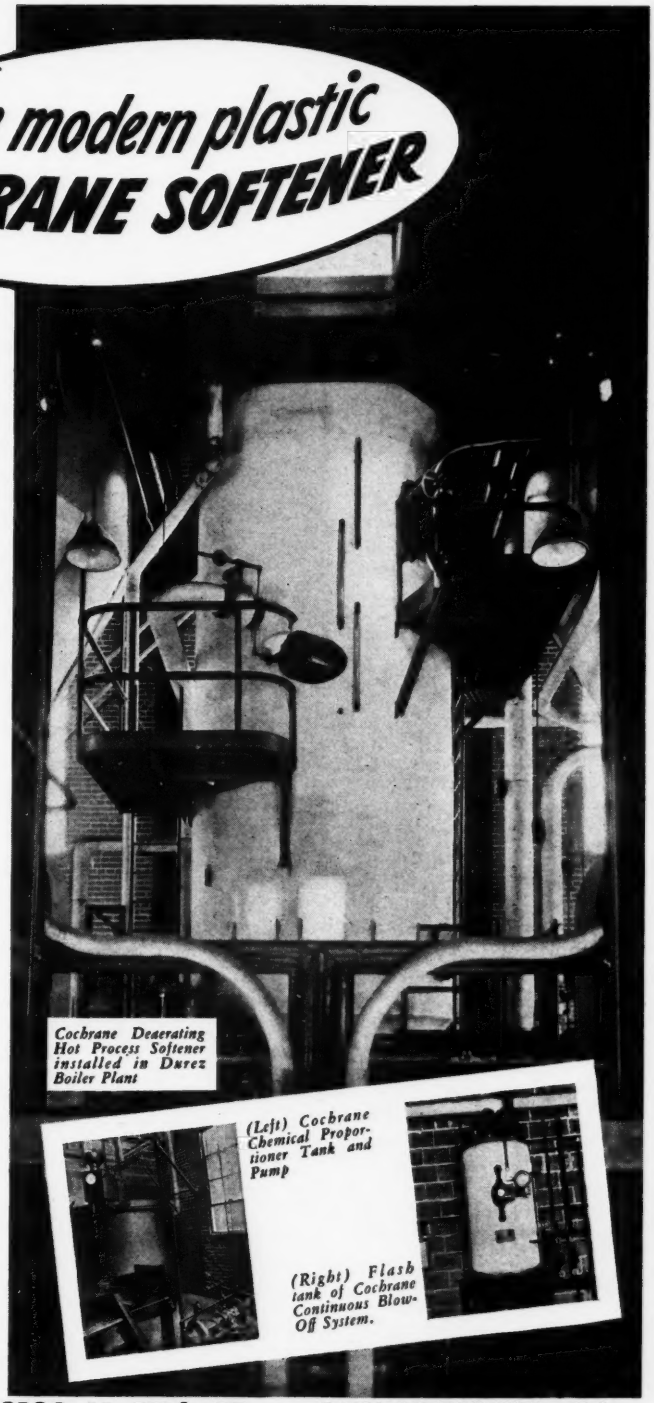
for the model boiler plant of the ultra-modern Durez factory at North Tonawanda, N.Y.

New steam plant for Durez Plastics & Chemicals, Inc., N. Tonawanda, N.Y.

AT North Tonawanda, N.Y., the fast-growing business of Durez Plastics & Chemicals, Inc., necessitated the building of a new synthetic phenol plant, which includes a separate building housing the steam plant which furnishes process steam and power.

For feedwater treatment supplying the two 45,000 lb./hr. 2-drum boilers, a Cochrane Deaerating Hot Process Softener was installed. The plant has been in operation since February, 1940, and this feedwater treatment has yielded highly satisfactory results. A Cochrane Continuous Blow-Off System is also a part of this boiler plant, adding the proven economies of continuous boiler blowdown to the many other "planned efficiencies" of this model plant.

Publications describing the type of equipment installed at Durez will be mailed upon request.



Cochrane Deaerating Hot Process Softener installed in Durez Boiler Plant

(Left) Cochrane Chemical Proportioner Tank and Pump

(Right) Flash tank of Cochrane Continuous Blow-Off System.

COCHRANE CORPORATION • 3123 N. 17th ST. • PHILADELPHIA, PA.

COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • DEAERATORS • BLOW-OFF EQUIPMENT • VALVES • FLOW METERS

(Continued from Page 104)

Technical sessions are serious moments

stokers would have much narrower retorts than existing stokers; the functions of distribution, coking and delivery would be separated; a pulsating air blast would be employed; it would require overfire air; and a deeper fuel bed would be maintained.

In reviewing recent data relating to the fusing temperature of coal ash as well as of ash and slag from pulverized coal-fired furnaces of both slag-tap and dry-ash-removal types, E. G. Bailey expressed the opinion that the highly oxidizing conditions in parts of both types of furnaces and the effect upon the slag-and-ash formation cause questions to be raised regarding the greatest usefulness of the present A. S. T. M. standard fusing temperature method on a reducing atmosphere alone. He suggested that further research is needed, and maintained that the surest way of finding the most suitable coal is the old way of actually testing a given coal in the plant where it is to be burned and learning its characteristics and the results from over-all performance. Actual work is progressing along the line of furnace and boiler design wherein variations in the characteristics of coal and its ash are of diminished importance.

Feedwater Treatment

One of the problems of boiler operation at high pressures is the trouble encountered with silica. This trouble appears to be more prevalent where the heat rate inputs are high and occurs irrespective of high or low silica content in the boiler water. An entire session of the meeting was devoted to a discussion of this problem at which Harold Farmer outlined the urgent need for more basic knowledge regarding the behavior of silica in boiler water, also satisfactory methods for determining the form in which silica exists in the boiler water.

Howard L. Tiger outlined and gave results of a newly developed magnesium process for silica removal which lends itself advantageously to a modified Spaulding precipitator type of construction at either low or high temperature to be followed by suitable treatment with carbonaceous ion exchanges for complete removal of residual hardness and reduction of alkalinity to any predetermined figure.

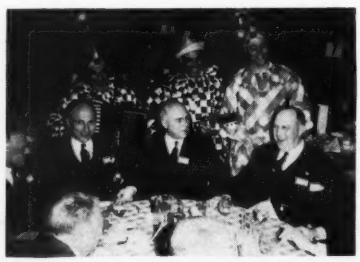
Further light on the subject of removal was given by L. D. Betz, C. A. Noll and J. J. Maguire who are employing a magnesium oxide process which is well adapted for use in conjunction with hot process lime-soda softening. Removal is effected, not by a chemical reaction, but by adsorption from solution.

At the other feedwater session, C. B. Arnold, R. T. Hanlon and J. Mindheim described the treatment of make-up water for the Waterside topping installation which is a special adaptation of the cold water carbonaceous zeolite treating system. At this session also, F. G. Straub and E. E. Nelson described a new degasifying steam condenser developed for use in conductivity determinations. This unit will furnish, automatically, a continuous sample of either steam or condensate which is free from dissolved gases but which contains the dissolved solids which were present in the original sample.

Piping

Finding the mathematical methods available for determining force and moment reaction caused by temperature expansions in pipe problems extremely laborious and complex, Fred M. Hill developed a model for the solution of such problems which is especially well adapted to the more complicated layouts. He explained the use of round slender steel rods to simulate large size pipe runs and compared the results he has secured from his model with those calculated mathematically.

Just what a throttling orifice will do to a jet of water has long been a debated subject. It remained just that until M. W. Benjamin and J. G. Miller put the movie camera to work in their investigation of the subject and engineers now have not only theoretical calculations but actual tests and photographs to show the flow characteristics of saturated water and of various mixtures of saturated water and steam through sharp-edged, thin-plate orifices.



Even clowns have fun when Iddles, Bailey, Gates and Funk tell jokes

Hydraulics

In hydroelectric power plants engineers are finding need for a more strict accounting of the water flowing through the turbines, and it was to this problem that J. M. Mousson directed attention in discussing the turbine discharge metering at the Safe Harbor hydroelectric development. The type of equipment was described in detail, as well as its adaptation as an automatic guide to operation which has resulted in appreciable benefits through higher operating efficiencies.

Reporting on the development of a new type hydraulic turbine, R. V. Terry described the design and presented test data on a model runner of an adjustable-blade type wherein the blades move automatically with changes in flow through the runner, as well as with changes of speed and head. At the present stage of development, it is not possible to explain all the various characteristics by mathematics and hydro-dynamics but the tests indicate that the principal objectives have been accomplished by the design.

Instruments

New in the field of flow meters is the Annis meter which was described by M. B. Macneille and Russell K. Annis as an instrument for measuring flow at the intake end of closed conduits and was developed primarily for measuring the rate of flow in impeller pumps. In principle it measures the difference in pressure between the water at the same level inside and outside the suction intake, and this reading is translated into flow of the liquid.

For detecting flaws in nonmagnetic metals, the employment of an eddy-current method was described by Ross Gunn. In applying the method, a predetermined pattern of electrical eddy currents is induced in a perfect test sample by alternating magnetic fields. Sensitive pickup coils properly disposed in relation to the eddy currents measure only the departures of the eddy-current pattern from the pattern in the perfect sample.

There's more to POWELL QUALITY than meets the BUYER'S EYE!

ONLY THE FLAWLESS VALVES GET BY THESE SKILLED CRAFTSMEN . . .

The illustration here shows a section of the testing room for the smaller Powell Valves . . . these men have but a single job, a single thought — to see that no Powell Valve is going to have the slightest chance of a leak through packing chamber, bonnet, or seat when **you** put it in service . . . so scientifically analyzed by our own Metallurgists that the material in every Powell Valve is free from all imperfections—so carefully machined that every thread, every joint, every face has the **precision** to admit the interchange of any and every valve part with that of any other Powell Valve of same size and type . . . yet all the design, engineering, and precision machining put into a Powell Valve would go for naught if that valve would not stay leak-proof in service . . . these men in the testing room know that —and that's why only **flawless** valves leave this department of the Powell plant, ready for a long life of useful service on the lines in **your** plant.

The cut of the valve shown above illustrates a Powell Bronze Gate Valve . . . There's a Powell Valve in all sizes, for all pressures and temperatures — including a complete line for all services of processing . . . consult the Powell distributor in your vicinity on prices and deliveries, or write us for catalogs and more details.

THE WM. POWELL COMPANY
CINCINNATI, OHIO

You Need More Than a Photograph of the Finished Product to See ALL of the Qualities that Make Powell Valves Uniquely Able to Better Serve the Power Engineer

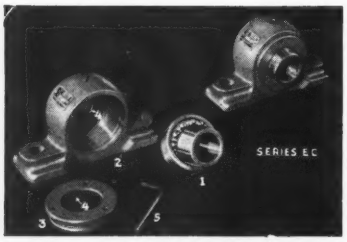
POWELL VALVES

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Improved Pillow Blocks

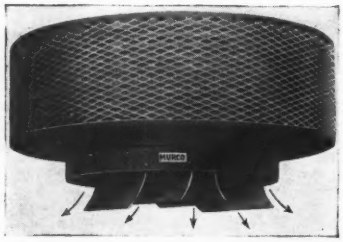
AHLBERG Pillow Blocks, Series EC, manufactured by Ahlberg Bearing Co., Chicago, Ill., are now equipped with Neoprene (synthetic rubber) seals to protect the bearings and retain lubricant. These seal rings turn with the shaft and float in the housing. They are of the labyrinth type, frictionless and long-wearing. Complete units consist of full self-



alining, precision ball bearings, mounted in one-piece Parkerized, accurately machined, housings. Compact and simple, the design lends itself to light and normal service where reliable yet inexpensive bearings are required. Picture reference: (1) Self-alining ball bearing, (2) One-piece housing, (3) Removable end cap, (4) Labyrinth seals, (5) Mounting wrench.

Unit Heaters

VERTICAL projection type unit heaters, the M Series Murco are announced by D. J. Murray Mfg. Co., Wausau, Wis. As an addition to its present line of unit heaters. The new heaters are made with the heating element all-copper and bronze, with few brazed joints. The copper fins

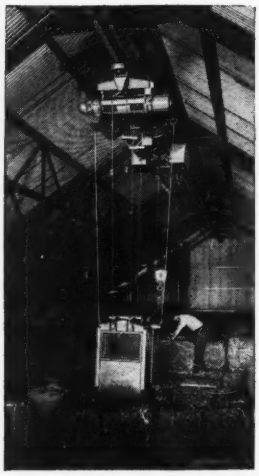


are metallically bonded to the copper tubes. Some of the uses for verticle projection type unit heaters are in blanking of cold drafts in front of doorways, buildings and industrial plants, warehouses, garages with high ceilings or any building that has a wide area to be heated. They are made in 11 models to meet various requirements.

Tramrail Carrier

THE CLEVELAND TRAMRAIL DIVISION of The Cleveland Crane and Engineering Co., Wickliffe, Ohio, has developed a new type of Tramrail Carrier with raise-lower cab available in two general forms. One form provides for the raising and lowering of cab and load together. The other provides for the cab and load raising and lowering independently of each other.

With a raise-lower cab unit one operator may take care of all operations involved in moving materials with an electric cab-controlled overhead Tramrail system: attaching load to crane hook, detaching, and operation of the Tramrail



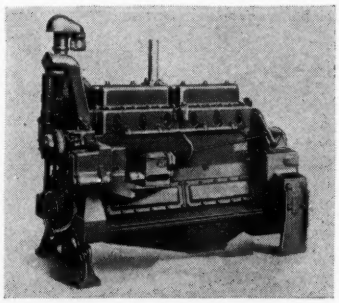
unit. If the materials are of such nature that a lifting fork need be employed, one operator can also handle the entire job just as with a crane hook.

In the unit illustrated the cab and load hook are operated independently of each other. During the day shift when large quantities of material are moved to keep up the production, the cab is kept in the upper position firmly attached to the Tramrail carrier. Three men are then employed, one for attaching loads, one for detaching at receiving end, and the third for operation of the Tramrail unit. During the night shift when the demands for materials are not so great, the cab operator alone, through use of the raise-lower cab, takes care of the entire job.

Heavy Duty Gas Engines

THREE MODELS of heavy-duty natural gas engines have been announced by Caterpillar Tractor Co., Peoria, Ill., in two cylinder sizes, the Model 4600G a six cylinder unit and the 4400G a four. Both of these engines have a bore of 4¾ in. and a 5½ in. stroke and they develop 74 and 48 hp. respectively at 1600 maximum governed r.p.m. A small four, the Model 3400G with a bore and stroke of 3¾ in. by 5 in. develops 34 hp. at 1650 r.p.m.

In the three valve-in-head engines, designed for heavy duty work with a minimum of maintenance, heat resistant alloy valve seat inserts are provided, and superfinished crankshafts with Hi-Electro hardened journals.



The lubricating system provides efficient filtering and full pressure lubrication to all working engine parts, with an upper-cylinder lubricator to provide extra valve lubrication for use with dry natural gas fuel..

All three models of engines are available fan to flywheel, or as a complete power unit package with enclosed clutch and radiator.

Valve

A NEW bronze globe valve has been recently announced by the Reading-Pratt & Cady Division of the American Chain and Cable Co., Inc., Reading, Pa.

This valve has a full-plug type seat and disc, designed for throttling services on high temperature and high pressure

steam lines. It is also suitable for use on high pressure lines carrying boiler scales and other gritty substances. Body is made of a special hard bronze, disc and seat of heat-treated stainless steel, 500 Brinell Hardness, and stem is high strength wear-resisting bronze.

in 1929 THOMAS A. EDISON wrote—

The first and best source of power is Coal

—and it's even more true in 1941!

The story of power is one of amazing progress . . . but improvement in generating equipment is only part of it. Coal has kept pace! Coal today is not what it was twenty years ago—or even ten. With improved methods of utilizing coal have come better methods of mining it . . . of cleaning and sizing it . . . of maintaining uniformity of performance, of coal delivered *in accordance with industrial engineering specifications.*

Modern coal is a better fuel to do a better job—at lower cost.

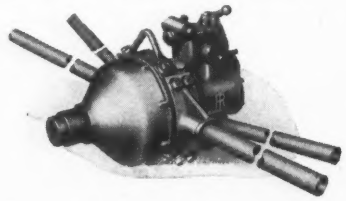
Let our engineers show YOU the way to modern savings
In industrial power plants, large and small, modern coal in modern equipment is producing increased efficiency, lower maintenance charges, more dependable operation—lower fuel costs. Is this true in *your* plant?

Chesapeake and Ohio maintains a staff of Fuel Service Engineers whose job is to help industry get more economical, dependable power for its fuel dollars. Their services are free of charge. If you'd like them to survey your plant, confer with your engineers and make suggestions for cost-cutting, write GEORGE H. REINBRECHT, Coal Traffic Mgr., 2903 Terminal Tower, Cleveland, O.

IT PAY$ TO U$E MODERN . . .
Chesapeake and Ohio Lines

Flue Rolling Machines

INGERSOLL-RAND Co., New York, N. Y., has recently introduced two new flue rolling machines; sizes 55-Q and 55-R, both powered by Multi-Vane type air motors. The machines have been built especially for rolling extra large



tubes as used in oil refinery stills; tapping for, running in or removing large pipe plugs; tapping flue sheets in large boilers; heavy reaming such as propeller shaft coupling, and for practically any extra heavy work of similar nature. The manufacturer states that the working speeds of these machines are very low, with correspondingly high torque, the size 55-Q having an average working speed of 32 r.p.m., the size 55-R of 20 r.p.m. and approximately 50 per cent greater torque than the 55-Q.

Respirator

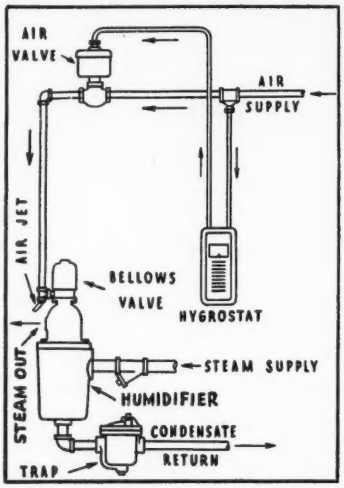
FOR PROTECTION against fumes of metals such as generated when burning, pouring or molding lead, cadmium, zinc, etc., a new respirator manufactured by the Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa., approved by the U. S. Bureau of Mines and employing the basic M. S. A. Comfo Respirator design, affords comfort and protection to workers. The unit provides complete working freedom, permitting use of goggles or headgear of any kind without interference.

Construction features are: filters of unique design, having high filtering efficiency against fine metal fumes; filter area more than double that of regular Comfo dust filters; aluminum filter containers, assuring long filter life by keeping out grease and dirt; all-rubber facepiece which fits any face snugly and comfortably; U. S. Army-type exhalation valve simple and positive in action. The new unit is named M. S. A. Comfo Metal Fume Respirator.

New Air-Operated Humidifier

DEVELOPMENT of an air-operated steam-type humidifier for installation in locations where electric circuits would be undesirable was recently announced by Armstrong Machine Works, Three Rivers, Mich. It is believed that the unit will have a considerable field of use in plants having processes involving explosion hazards.

As shown by the accompanying diagram, the assembly includes a pneumatic hygrostat which acts as a pilot valve to admit pressure to the diaphragm chamber of the main air valve when the relative humidity drops below the desired percentage. Opening of the main air valve allows compressed air to flow to the humidifier, when the pressure builds up



and opens a steam valve in the top of the humidifier. The steam valve admits steam to a special silencing chamber in the humidifier, whence it escapes directly to the atmosphere to add humidity to the room. Circulation and distribution of the steam is facilitated by allowing a small amount of compressed air to blow through a nozzle directly above the steam outlet.

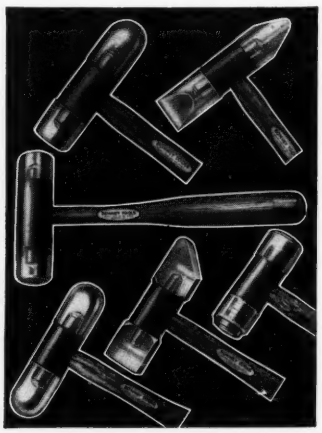
To insure dryness of steam released by the humidifier, the entire silencing chamber is jacketed with steam at a pressure several pounds above atmosphere. Use of a steam trap prevents accumulation of condensate in the steam jacket. Compressed air for the humidifier may be at any pressure from 20 to 100 lb. or less. The unit has a maximum capacity for addition of moisture to the air at the rate of 44 lb. per hour. Under average conditions this is sufficient for 40,000 cu. ft. of space.

Soft Face Hammers

TO MEET the increasing need for soft face hammers, Bonney Forge and Tool Works, Allentown, Pa., have recently added five new types to their line.

These new types and sizes are especially useful where a hammer is required that will not mar finely finished surfaces or delicate machine parts. The new shaped tips are especially useful for forming and working light sheet metal.

These are available with one regular face tip and one ball pein tip; with one straight pein tip and one cross pein tip; with two ball pein tips; with one square tip and one offset pein tip; with two regular face tips and with one regular face tip and one regular face tip with brass insert.



Tips in all cases are renewable. They are made of a tough, amber colored, cellulose composition that will not shatter or chip.

Hickory handles have comfortable grip and are securely wedged in the steel center body.

Many of the hammers have the same size tip studs and tips are, therefore, interchangeable for those hammers.

Head weights range from 1½ oz. to 2 lbs. but not in all types.

Proportioning Pump

NEW FEATURES in the Nelson Chemical Proportioning Pump are announced by the distributors, D. W. Haering & Co. of Chicago, as follows: Changed inlet and outlet valves in the feeding end to decrease friction; monel metal discs of the poppet valves have diagonal grooves to impart rotary motion when operated; oil cup to replace grease cup on bearing; new sizes, using alloys to prevent corrosion.

Power Plug and Sockets

NEW 500 Series power plugs and sockets, designed for 5000 v. and 25 amp. and made in 2, 4, 6, 8, 10 and 12 contacts have been recently announced by Howard B. Jones, Chicago, Ill.

All sizes are polarized so that it is impossible to make incorrect connections, even when using several sizes on a single installation. The cap is arranged so that a standard cable clamp can be used, connections are easily made, and cap body can be removed for inspection without distributing wiring. Design of the unit prevents the fingers from coming in contact with the prongs while they are still in contact with the socket terminals, avoiding possibility of a shock or injury.

Vogt

for better DROP FORGED STEEL *Fittings*

in SOCKET WELD *and* SCREW END TYPES

SOCKET WELD TYPE

Schedule 40—(Standard)
Schedule 80—(Extra Heavy)
Schedule 160 & Double Extra Heavy
Sizes 1/4" to 6"

Choose either type with Confidence, when Drop Forged by **VOGT!**

Vogt drop forged material is uniform in structure, fine grained and free from porosity, with a "plus" of strength and toughness that safely withstands the strains and shocks of service at high temperatures and high pressures. Ells, Tees, Crosses, etc., are available in various alloys to meet any of your special service conditions.

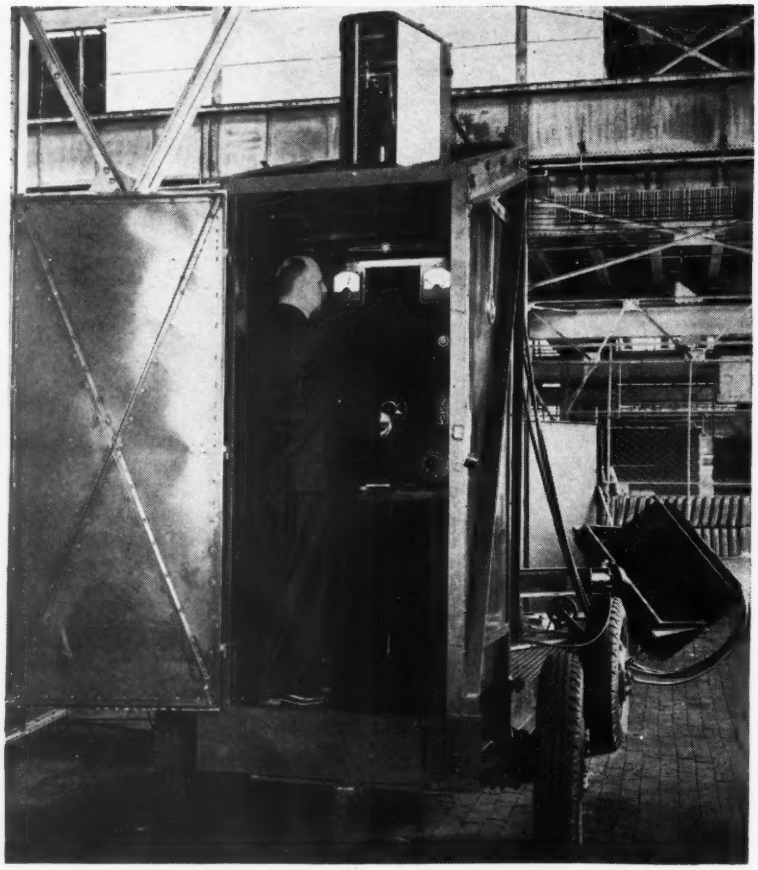
WRITE FOR BULLETINS OR ANY SPECIAL INFORMATION

SCREW END TYPE

2000 pound 3000 pound
6000 pound
Sizes 1/8" to 6"

HENRY VOGT MACHINE CO., Incorporated, LOUISVILLE, KY.

BRANCH OFFICES: NEW YORK · PHILADELPHIA · CLEVELAND · CINCINNATI · ST. LOUIS · CHICAGO · DALLAS



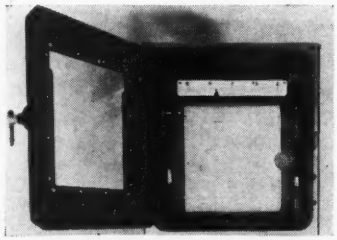
Spots Castings Defects

To CHECK the perfection of castings and welded parts which go into products of the Erie Works of the General Electric Co., industrial X-ray equipment as shown here is used, to spy on the "innards" of castings or other metal parts before machining operations are started in order to detect any concealed flaws in the metal. This equipment is useful in the investigation of parts such as armature and commutator spiders and the like. The equipment pictured, rated at 75 to 220 kv. peak at 10 ma., is on mobile truck-type mounting. It is completely shockproof, all high voltage equipment including X-ray tube and high-voltage transformer being oil-immersed in a grounded metal case. Control panel is mounted in a lead-lined booth at the rear of the truck to protect the operator from continual exposure to the X-rays. The machine weighs 7000 lb. and its rays will penetrate about 3½ in. in steel.

Dissolved Oxygen Recorder

CAMBRIDGE INSTRUMENT CO., INC., Grand Central Terminal, New York City, has developed an automatic, continuous instrument to record dissolved oxygen in water. The instrument is sensitive to 1 part in 400,000,000. The continuous record detects leaks or other sources of entry of oxygen into the water in the feed cycle and, being automatic, does not depend on skill of an operator. The Dissolved Oxygen Recorder has a range from 0 to 1 p.p.m. of oxygen and variations of 0.01 p.p.m. are easily detected, since they will show as 0.1 on the 10-in. wide chart.

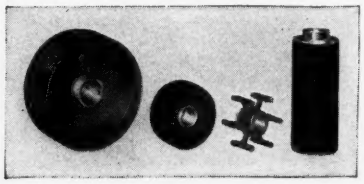
Operation of the instrument is based on thermal conductivity, four platinum spirals being used to form arms of a Wheatstone bridge. Sample of the water being tested is passed under constant head through a cooling coil, which maintains the sample at about 85 deg. F. Cooled water passes to a scrubbing tower, where it comes in contact with hydrogen, which is generated in an electrolytic cell, the water dissolving some of the hydrogen and giving up part of its oxygen. Resultant mixture of gases diffuses to the



meter block, which contains the Wheatstone bridge spirals, that are heated to a definite temperature by current passed through them. Two of the spirals are exposed to the sample gas and two are permanently sealed in a chamber filled with saturated hydrogen.

New Fiber Rolls

CONSTRUCTION for small and medium sized rolls with tough hub, and spider of zinc alloy cast into the fibre body is announced by Rockwood Mfg. Co., Indian-

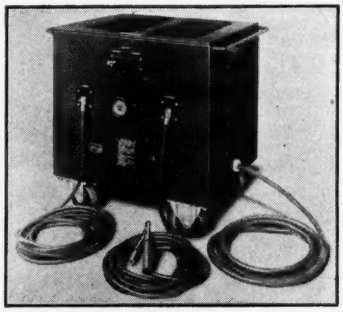


apolis, Ind. Good machine performance, long life, accurate speed and low belt slip are claimed for these rolls, which can be made in any dimensions required.

Small Size Weld-O-Tron

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., originator of the 5 to 75 amp. Weld-O-Tron low current electronic arc welder for light gage metals, has now added a Junior size to its line for a range of 5 to 40 amp. It is especially designed for those plants already equipped with motor generator welders that handle currents as low as 35 to 40 amp. Like the larger Weld-O-Tron unit, this smaller size supplies currents as low as 5 amp. and uses electrodes as small as $\frac{3}{32}$ and $\frac{3}{64}$ in. in diameter. It is especially suited to welding gage sizes from No. 32 to No. 18 which heretofore could not be welded satisfactorily, and is capable of handling material as thick as No. 14 gage.

The Junior size Weld-O-Tron electronic arc welder consists essentially of a three tube polyphase mercury vapor rectifier circuit—thus eliminating all rotating parts. It makes use of the company's Actron type of rectifier tubes which have proven so successful in the larger size Weld-O-Tron unit. It combines all the advantages of a.c. and d.c.

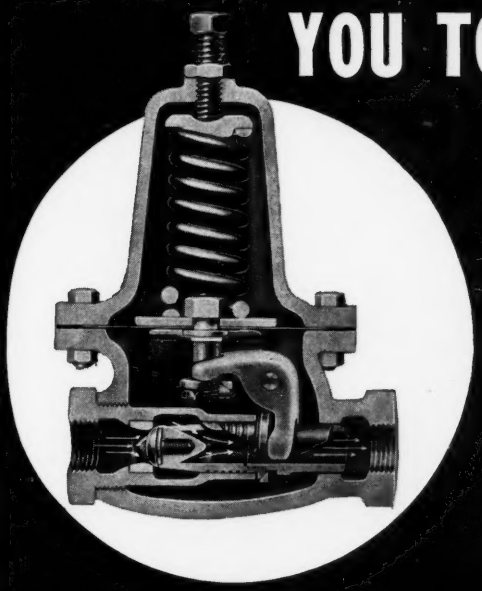


arc welding. Being of light weight and portable are of advantage in any plant.

Readily accessible controls and terminals are located on the front panel. They are of the dead front type and consist of a simply two way switch for changing the polarity of the output terminals. A handwheel with easily read dial provides fine adjustment of the welding current.

According to the company, the constant current characteristic of its larger unit has also been given to the Junior Weld-O-Tron—making the arc easy to start, easy to hold, and producing an optimum heat condition at the weld. The same characteristics are obtained from minimum to maximum current settings.

IF YOU KNEW *what users know* YOU TOO COULD SAY—

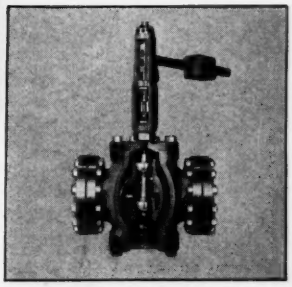


"low cost performance"
"trouble-free service"
"accurate regulation"
"tight closure when not in use"
"no service attention"
"high capacity"
"speeds production"

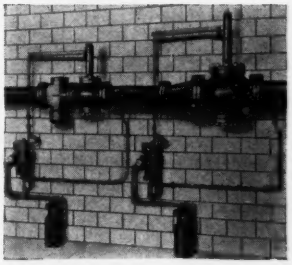
A CASH STANDARD "GET ACQUAINTED" COLUMN

Question: "Don't you people make anything besides that Streamlined Valve you talk about so much?"

Answer: "Yes Sir; we do! And we propose to picture one or two of them here each time."



For precision jobs — the CASH STANDARD "42-R" Balanced Lever Valve. No lost motion; practically no maintenance. Heavy renewable seat rings; valve stem integral with inner valve. Roller guides kill side strains and stop packing trouble. Comes with parabolic inner valve; flat bevel seat; V-port seat; and V-port non-seating types. Made in sizes ½" to 12" inclusive. For use with pressures up to 600 lbs. Highest temperature 800 deg. F. In iron, bronze, and steel bodies; all standard trims. This valve is made also with center guide, and with Water Cooled, or Air Cooled Packing Box.



Where valve failure would be costly, here are two "42-R" Valves operated by CASH STANDARD Type 100 Automatic Controllers, in two-stage pressure reduction. First stage: a 5" Valve reducing 150 to 50 lbs. gauge; second stage: an 8" Valve reducing 50 to 5 lbs. gauge. Load 70,000 lbs. steam per hour. Nearly four years' daily use; not a moment's trouble. (Single stage would have been entirely satisfactory, but customer insisted on double stage reduction.)

NONE OF THIS TURBULENCE
In the Streamlined Valve there is no turbulence like that indicated in the diagram above to hinder flow or handicap close pressure regulation.

GIVES THIS FLOW PATTERN
The Streamlined form of the inner valve eliminates turbulence. It produces the flow pattern shown above which makes for maximum capacity when it is needed most, and permits accurate pressure control under toughest working conditions.

USERS SAY—
Lots of Valves must be working well because no troubles reported —

"We've got a lot of your Streamlined Valves here and they must be working well because I haven't had a single case of trouble reported on them. When something works well we usually stick to it, so you'll be hearing from us right along."—Case No. 366.

Wanted dependable Valves — Streamliner stood Lab tests — 5 years of plant experience confirms Lab test —

"Bought the first '1000' Valve because we were on the hunt for a dependable Valve. Laboratory tests were so good we standardized on it. Plant use confirmed Lab tests. With practically no trouble with any of these Valves over a five-year period, we are not on the hunt anymore."—Case No. 369.

CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVES

have straight line flow from inlet to outlet . . .

Why not find out why users get no failures with the CASH STANDARD Streamlined "1000" Valve — why it gives them much longer, lower-cost service, and why attention costs are materially decreased.

It Costs You Nothing to Find Out

You can get the CASH STANDARD Streamlined Type 1000 Valve working for you at once — at no cost you can experience the benefits of this "straight line flow" construction.

Simply send for a Type 1000 on 30 days' FREE TRIAL. After 30 days a bill is sent to you. You either pay the bill or return the valve to us at our expense.

Once on your lines, Type 1000 insures maximum capacity and close delivery pressure control. You'll find that there are no complicated parts to get out of order — no small ports or passages to clog up — no close fits — also that you are easily able to meet peak demand and yet hold the pressure constant at the same time.

Order one on Free Trial now!

CASH STANDARD CONTROLS . . VALVES

A. W. CASH COMPANY
DECATUR, ILLINOIS

Get Free Bulletins on Above . . . Write to
A. W. CASH COMPANY
DECATUR, ILL.

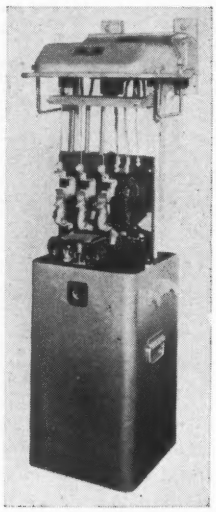
Sight Feed Oiler

ANNOUNCED recently by S. F. Bowser and Co., Fort Wayne, Ind., is the new Pressure Sight Feed Oiler, designed particularly for lubricating elevated or out-of-the-way bearings. Installation at eye level permits the machine operator to tell at a glance the flow of oil to a bearing and approximate amount.

The oiler is an especially desirable feature on calender stacks and dryers in paper mills, as well as on many other types of industrial machinery where points of lubrication are difficult for the operator to see if the bearings are properly lubricated.

Oil-Immersed A.C. Starter

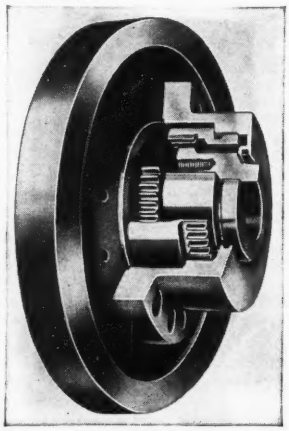
FEATURING ease of installation and better protection against corrosion, General Electric Co. has developed a new oil-immersed combination a.c. starter for use in corrosive or hazardous gas locations, available in two forms, with or without a circuit breaker, depending upon the application.



To facilitate installation, a one-piece cast-iron head, used in both forms, permits conduit entrance from five directions As protection against external corrosion, stainless steel and Monel metal are used for all exposed parts, a copper-bearing steel tank and cast-iron head providing additional protection. Reversible tips prolong contact life, while protection against harmful overloads is supplied by an isothermic induction-temperature relay, immersed in the oil. Where other provisions have been made for short-circuit protection and disconnecting, a circuit breaker is not included with the control. Where such protection is needed. however, the breaker supplied is a new type, rated at 10,000 amp. interrupting capacity and specifically designed for operation under oil. For extra safety, the handle of the circuit breaker is interlocked with the tank so that the breaker must be open before the tank can be lowered, preventing possibility of lowering the tank while the starter is energized. The handle of the breaker can also be padlocked in either On or Off positions to prevent unauthorized operation. To protect an operator from coming in accidental contact with power lines, incoming lines are inclosed in insulating ducts.

Flexible Coupling

THE MANGER coupling, designed and developed by Farrel-Birmingham Co., Inc., Buffalo, N. Y., provides complete flexibility with small axial clearance and eliminating dummy, pilot or stub shaft. It is applicable for connecting two free-ended shafts in combination with a solid, flanged, half coupling, and for connecting a shaft directly to a flywheel, brake drum or flange.



When two units are coupled to a single driver, it is possible to operate one unit by unbolting the coupling and drawing back the outer sleeve on the unit which is not to be used. As the hub on the driver is solid, there are no loose parts to interfere with the free rotation of the driving shaft.

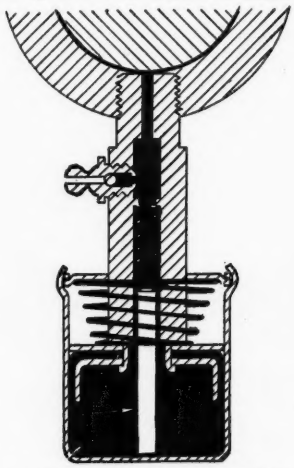
For connecting shafts of different diameters, the flexible member is mounted on the smaller shaft and bolted to a rigid, flanged, half coupling on the larger shaft, the size of the flexible member being determined by the size of the smaller shaft.

Compensation for misalinement is made by an internal sleeve which floats between an externally geared hub and an internally geared covering sleeve, the internal sleeve, which engages the hub and outer sleeve, being free to slide and rock. The driving member of the coupling can be either the geared hub or the covering sleeve. External teeth are crowned to give full freedom to the floating sleeve within design limits of the coupling, with compensation for offset, angular and combined misalinement.

This coupling is suitable for all usual applications as well as connecting shaft to engine flywheel; connecting one shaft to another which carries an overhung brake drum; connecting shafts of different diameters; connecting driving shaft to roll or pinion stand when radial clearance is small; and for combination with a magnetic or pneumatic clutch coupling.

Automatic Lubricator

ACE LUBRICATING EQUIPMENT CO., Inc., Detroit, Mich., recently announced its new Ace lubricator. Filled with a grease gun, this lubricator is automatic



in its feeding of lubricant, eliminating over or under greasing and overfilling, shows when refilling is necessary, is self-contained and can be quickly disassembled for cleaning, and by means of adaptors can be applied for any type bearing where other than standard sleeve bearings are used.

New Lighting Fixture

NEW 200-w. Miraflume fluorescent lighting fixture, C-205, is announced by Hygrade Sylvania Corp., Ipswich, Mass. It is furnished complete with ornamental base carrying four 40-w. lamps in either daylight or white finish. Dimensions are 49 in. long, 14½ in. wide, 7½ in. high, weight 45 lb.

Chill Rings

WEDGE PROTECTORS, INC., Cleveland, Ohio, recently announced its new Wedge Chill Rings. These are made in two types, P-446-A for electric welding and P-446-B for gas welding and for pressure piping in all standard sizes up to 8 in.

Special features are the elimination of variables such as width of gap, operator's preferences as to amount of current and welding technique, and type of electrode used. The chill ring process permits fewer welding electrodes and easy alinement of pipe sections.

MURRAY

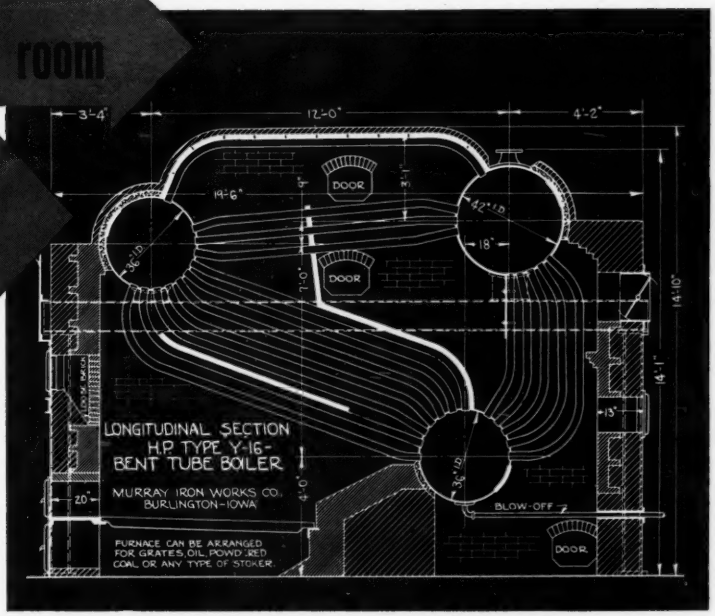
TYPE "A" BOILER

is an improved type of the straight tube level drum construction designed for a perfectly balanced circulation and a mechanical flexibility that insures repeat orders for this type of boiler.

Built with one, two or three drums, depending on horsepower required.

LOW in head room

LARGE in capacity



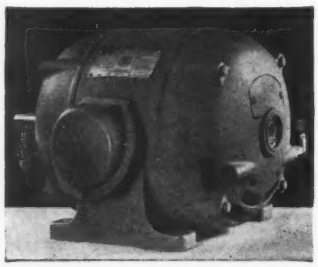
You'll find the Murray Type "Y" Boiler just the unit to install in cramped quarters. . . Its large steam drum gives liberal steam releasing area for the steam generated. And the boiler is baffled so that the entire heating surface of the main tube bank is exposed to the direct radiant heat of the furnace. . . Write us about your boiler problems.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA, U. S. A.

MURRAY

Sleeve Bearing Induction Motors

NEW OPEN-TYPE sleeve-bearing squirrel-cage induction motors designed especially for general purpose drive applications such as machine tools, pumps, auxiliary drives, and others, are announced by the Westinghouse Electric & Mfg. Co. These type CS motors are available in ratings from ½ to 5 h.p., at speeds from 875 to 3600 r.p.m., for operation on 110, 220, 440, and 550 v., 2 and 3 phase a.c. More attractive and compact than ever before, the new motors are also strong mechanically. Rigid complete-cast

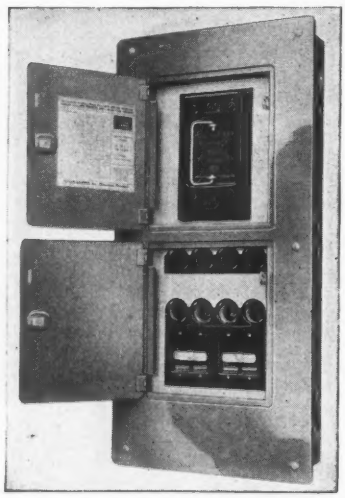


frames maintain constant air-gap between stator and rotor, assuring high efficiency operation. Frame improvements include new sealed sleeve bearings having a combination vestibule and felt washer seal, and a larger oil reservoir capacity. Oil filler cups may be inserted on either side of the motor.

New wire insulation gives maximum dielectric strength, toughness, and flexibility. Combination slot cells, with reinforced cuffs, protect windings from abrasion, and coil ends are taped for reinforcement against strains of full voltage starting. All motors are dynamically balanced, and windings are given a high-voltage radio frequency test.

New Switch

NEW LINE of 100-amp. pull-out type service control is announced by Cutler-Hammer, Inc. The switch is available with or without branch circuits, the 100-amp. pull-out type being rated at 230 v.



It is also available with two 60-amp. pull-outs; and 4, 6, or 8 plug fuse circuits rated 115/250 volts.

Features are dead-front construction; bakelite switch base; 3-wire grounded solid neutral; new type solderless lugs on all 60 and 100 amp. terminals; easy-tight wire holes on plug fuse circuit terminals; convenient fuse testing facilities; slots in cover and case for sealing purposes; ample wire space. The device is available in surface or flush mounting types; the surface type finished in aluminum; the flush type finished in grey enamel.

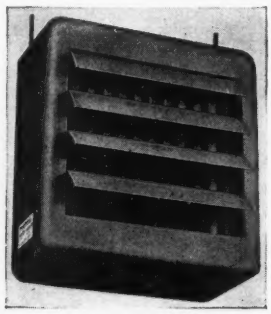
Rapid Whiteprint Machine

A NEW Model F Whiteprint machine has just been announced by Ozalid Products Division, General Aniline & Film Corp., Johnson City, N. Y. This equipment constitutes a printer and dry-developing unit built into a single, compact machine in which are incorporated all the facilities necessary to turn out finished dry-developed Ozalid Whiteprints.

Equipped with a new type high pressure mercury vapor lamp, which uses 40 watts per in. and has an active length of 46 in., the Model "F" will print Ozalid sensitized materials at speeds up to 56 in. per minute. The lamp gives uniform light distribution over the entire printing surface. It is guaranteed for 1,000 hours but tests indicate a life of from 1500 to 2500 hours. A Veeder-Root Counter automatically registers the number of hours this machine operates. This enables the operator to determine at a glance exactly how long the machine has been in operation.

Unit Heaters

D. J. MURRAY Mfg. Co., Wausau, Wis., announces the M Series "Murco" unit heaters, in a modern steamlined cabinet, steamlined non-air restricting motor supports, and die-formed fan shroud.



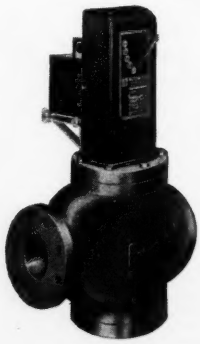
Design of the individual all copper turbospiral fin tube core provides an even distribution of heated air at high velocity. The entire unit is spring suspended and floats free in the casing, thus eliminating rigid connections between the cabinet and the unit. M Series Murco unit heaters are made in 27 different models for steam capacities, and 8 models for hot water capacities.

Thermostat Zone Control System

MINNEAPOLIS-HONEYWELL Regulator Co., Minneapolis, Minn., announces the Averaging Thermostat Zone Control System which is a new modulating system of control for two-pipe steam heating plants where a constant source of steam is available.

Suitable for single or multiple zone application, it employs two or more graduate-acting thermostats which are placed at representative locations in the zone and which position a modulating zone valve in accordance with their average demand.

Because the point of control is inside the space heated this system is particularly well suited to jobs where changes in occupancy or internal heat load are a



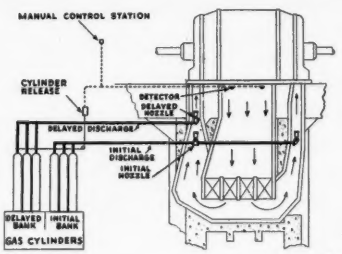
K901B MOTORIZED VALVE

major factor and where a single representative control location cannot be established. The flow of steam is continuous, which prevents expansion noises in the piping and eliminates cold radiators with the resultant stratification of air. Due to the fact that the amount of steam supplied to the system is varied it is necessary that all radiators be properly orificed, and that a relatively constant pressure differential be maintained between the supply side of the motorized valve and the system return.

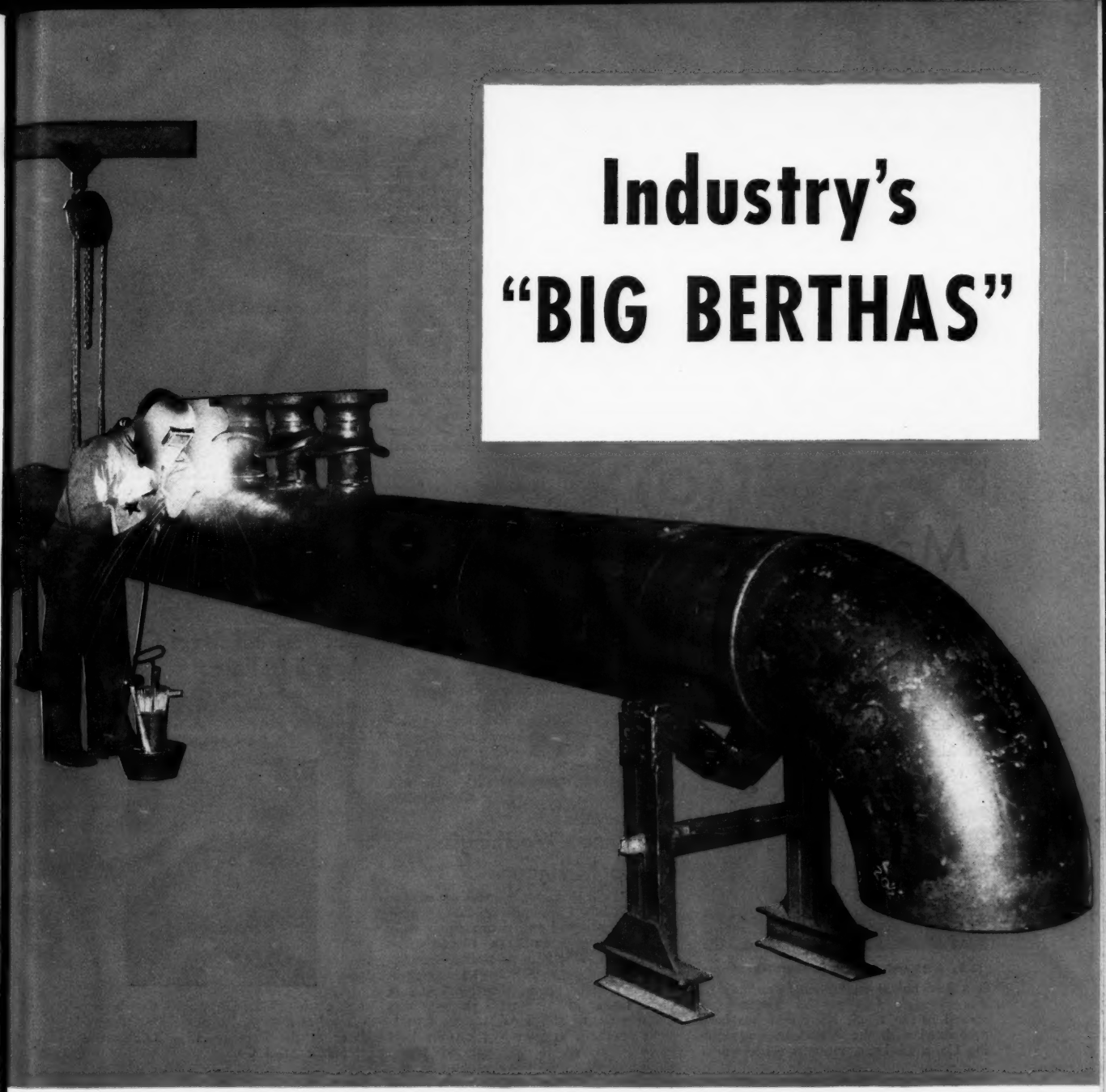
The system is available in either electric or pneumatic controls, with optional automatic night shutdown and morning pickup.

Generator Protection

A NEW development in the protection of rotating electrical machines from fire is announced by Walter Kidde and Co., 140 Cedar St., New York, N. Y. The development consists of the use of special shielded nozzles for the discharge of



carbon dioxide into the ventilating ducts of generators in event of fire. As shown in the illustration, the shielded nozzles are affixed to both the initial discharge and the delayed discharge pipes which carry the carbon dioxide from the storage cylinders to the ducts, and the refinement is said to eliminate objectionable high jet velocity and turbulence. Also the new nozzles aid in achieving a more rapid and uniform distribution of the fire-killing gas throughout the machine.



Industry's "BIG BERTHAS"

Speeded-Up by Interpretive Engineering!

To a wide variety of overloaded plants, Grinnell Prefabrication offers an important short-cut in expansion of power and processing facilities. Through this expert service, super-piping systems . . . "big guns" in industry's attack on modern production problems . . . often can be installed with savings of weeks.

That's why leading engineers now prefer to "give the plans to Grinnell." Layouts of plant requirements will be speedily interpreted into super-piping systems by experienced Grinnell specialists . . . then prefabricated by advanced, time-saving methods in fully-equipped plants. And promptly, on delivery date, accurate sub-assemblies bearing underwriters' approval are on the job . . . ready to install with minimum field welding!

Write for comprehensive manual on Grinnell Prefabricated Piping. Grinnell Co., Inc., Executive Offices, Providence, R. I. Branch offices in principal cities.

PREFABRICATION BY **GRINNELL**

WHENEVER **PIPING** IS INVOLVED

Corrosion Control

A REVOLUTIONARY method for the prevention and control of corrosion in steam and return systems is announced by D. W. Haering & Co., Inc., Chicago, Ill. The water soluble film inhibitor, quachrom glucosate, is introduced directly into the steam line in proportion to steam flow by means of a Haering Fluid Piston proportioning machine or a Nelson chemical proportioning pump. As little as five pounds of this substance will treat one million pounds of steam. Processes and equipment presenting specific corrosion problems may be treated individually by introducing the inhibitor immediately before the steam enters the equipment concerned. Plants purchasing steam from outside sources may treat the steam with quachrom glucosate before it passes into the steam system without regard to the source of steam.

In many cases, introduction of the inhibitor may be made directly into the main steam header. Sometimes the bulk of the condensate is returned to the boiler and the steam treatment may replace boiler water treatment entirely by adjusting the steam treating formula to meet the boiler water requirements.

Carobronze

CAROBRONZE is a bearing material, manufactured and distributed by Revere Copper and Brass Inc., New York, N. Y. The manufacturers state that some of its features are: Ability to carry high loads and speeds; remarkable ability to resist shock loads; freedom from consequential wear; lowest frictional resistance; high ductibility at temper of greatest strength and hardness; resistance to deformation under heavy loading; resistance to corrosion and erosion.

Manufacturers' News

American Engineering Company Promotions

C. E. HARRISON, vice president of the American Engineering Co., Philadelphia, Pa., has been appointed general manager with general supervision of the entire activities of the company. Mr. Harrison

C. E. Harrison

E. Sharninghausen

is a mechanical engineering graduate of the Carnegie Institute of Technology, served in the U. S. Navy and has been associated with the American Engineering Co. since 1913. He was made works manager in 1936 and was elected to the vice presidency in 1938.

The company also announces the appointment of E. W. Sharninghausen as treasurer. Mr. Sharninghausen formerly with the Otis Elevator Co., became purchasing agent of the American Engineering Co. in 1918, in which position he served with distinction until his recent elevation to the treasurership. He will continue to serve as director of purchases.

Travisano, Worthington Traffic Manager

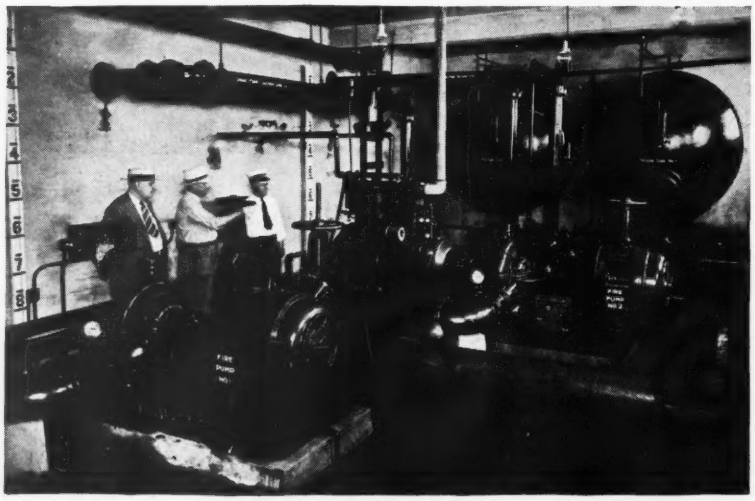
R. A. TRAVISANO, a member of the Traffic Club of Newark, N. J., well known to railroad and steamship officials in the Metropolitan Area, succeeds the late Mr. H. T. Smith as traffic manager of the Worthington Pump and Machinery Corp. He entered Worthington as a stenographer in 1912 and 3 yr. later was transferred to the local traffic department at the Harrison Works. In 1924 he was moved to the general traffic

department in the New York offices to handle the clearance of all exports of the corporation. Upon completion of the executive offices of the corporation at Harrison, N. J., in 1933, Mr. Travisano returned to the Harrison Works to become assistant to the late H. T. Smith.

Copperweld Steel Co. Appoints Karr

COPPERWELD STEEL CO., Warren, Ohio, makers of Aristoloy alloy steel, announce the appointment of R. A. Karr as metallurgist. Mr. Karr was graduated from

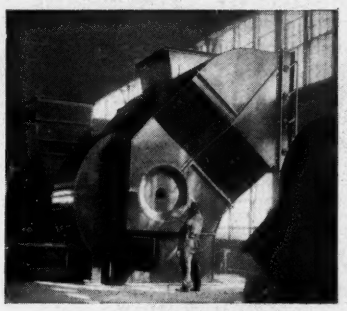
Lehigh in 1930. He was formerly employed at Battelle Memorial Institute and later at the Central Alloy Division of Republic Steel Co.

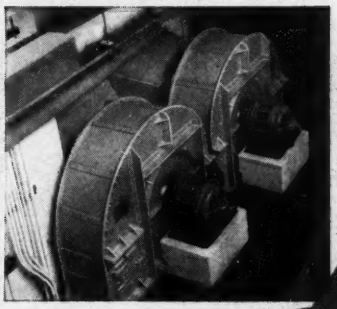


Installation of Fire Equipment

PRODUCTION on private planes was started at the Stinson Aircraft Plant in Nashville, Tenn., several months ago, but government contracts were deferred pending installation of fire protection equipment. Contract was awarded to W. L. Hainey & Co., using Fairbanks-Morse 1000 g.p.m., 6-in. underwriter's Fire Pumps inspected by Nashville Fire Department and final test resulted in approval. Final tests were made by (left to right) W. S. Smith, Western Factory Insurance Co.; J. W. Shelby, Tennessee Inspection Bureau; Capt. J. A. Scraggs, Nashville Fire Department.

Other equipment used at the Stinson plant was a 3-in. Fairbanks-Morse pump for circulating water in air conditioning systems, a 75-hp. motor, 1800 r.p.m., 3-phase, 60-cycle, 440 v. for driving fire pump, and 5-hp. motor to maintain pressure on pneumatic tanks.





Forced and Induced Draft Fans

Custom built for every mechanical draft service. All types of volume control. Efficient, dependable, durable, economical.

for

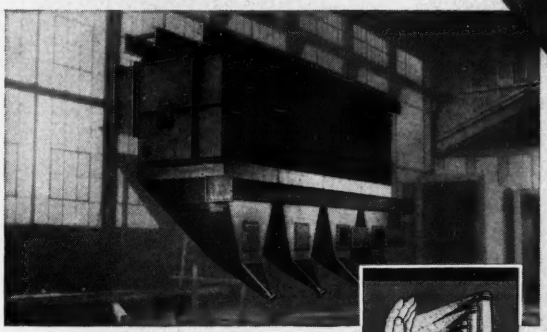
Increased Boiler Capacity

and **Lower Steam Costs**

consult **GREEN**—*first!*

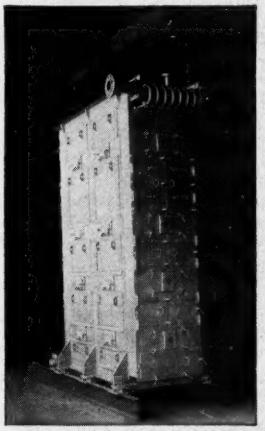
THE **GREEN** *Fuel Economizer* **COMPANY** INC.

BEACON NEW YORK



Cindertraps

For stoker-fired boilers. Good recovery—low draft loss (0.1" to 0.2"). Tested in accordance with the latest A. S. M. E. Tentative Code, issued December, 1939.



Cast Iron Economizers
(*right*)

A type still having many advantages as proven by years of service. Built for pressures up to 450 lbs. per sq. in.

Steel Economizers
(*left*)

High heat-transfer provided by extended-surface construction. A size for every service—pressures up to 1625 lbs. per sq. in.

Air Preheaters
(*below*)

Tubular and plate types. Waste heat recovery with minimum maintenance. Many in service throughout industry.

Write for complete information

G-E Appoints Coolidge and Crocker

THE appointment of Dr. W. D. Coolidge and Stuart M. Crocker as new General Electric vice presidents has been announced by Charles E. Wilson, president of the company.

Dr. W. D. Coolidge

S. M. Crocker

Dr. Coolidge will continue as director of the General Electric Research Laboratory in Schenectady. Mr. Crocker will relinquish his duties as manager of the company's air conditioning and commercial refrigeration department at Bloomfield, N. J., to make his headquarters in New York City where he will coöperate with and be assisted by all commercial departments in furthering the general interests of the company.

Noted for his own achievements with x-ray tubes, ductile tungsten and submarine detectors, Dr. Coolidge has been a member of the research laboratory staff since 1905 and director since 1932. He is a member of the National Inventors' Council recently created to encourage civilian inventions as part of the national defense program.

Mr. Crocker has been manager of the air conditioning and commercial refrigeration department since May, 1939, and a vice president of the International General Electric Company since 1930. His career with General Electric dates from 1921 when, after work in the traffic and sales departments of the Radio Corporation of America, he became assistant to Owen D. Young, then chairman of the boards of both R. C. A. and General Electric.

F. H. Babcock Promoted

FREDERICK H. BABCOCK, assistant to Vice President C. W. Appleton of the General Electric Co., has been appointed manager of the Central Station department of the New York District, as announced recently by Commercial Vice President H. H. Barnes, Jr. Mr. Babcock succeeds Mr. Appleton who is retiring because of ill health. Three years after graduating from the U. S. Naval Academy, Mr. Babcock joined General Electric as a student engineer, and was later assigned to the Central Station engineering department, and soon after became a commercial engineer of that department.

After service in the World War, he rejoined the Central Station department and on May 1, 1927, was made assistant to Mr. Appleton.

The position of sales manager of the New York District will continue to be filled by William E. Brown.

W. H. Feldmann

W. H. FELDMANN, vice president in charge of sales since 1937, has recently been elected general manager of Electric Machinery Mfg. Co., Minneapolis, Minn.

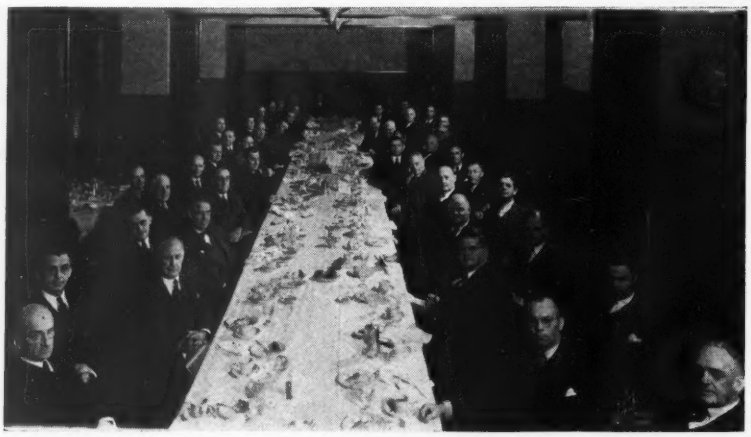
Mr. Feldmann has been associated with Electric Machinery Mfg. Co. for 18 years, having been in charge of district sales at Cleveland and Chicago before his appointment as general sales manager in 1927. He was elected a director in 1936.

C. H. Butterfield, Vice-President of Manning Maxwell & Moore, Inc., has sent out a letter to regular customers to explain the conditions created by the national defense program and to assure them of all possible effort to meet their needs. He says in part: "Your orders and orders from good customers like yourselves have kept us in business. Without them we could not have survived. Permit us to assure you that in the period of difficulties that may be ahead of us, we will give orders from you and our other regular customers prompt and continuous consideration throughout any emergency that may be ahead of us. We may not be able at all times to make fire-alarm deliveries —but we will be able to deliver our orders from you ahead of orders from new customers.

"During the past year we have made more additions to our organization to improve the quality of our personnel, and we are in better shape than ever to take care of an increase in business.

"You can help by placing your orders as far as possible in advance; but whether you do or not, we are set up to protect all the requirements that you may commit to us."

(Continued on Page 146)

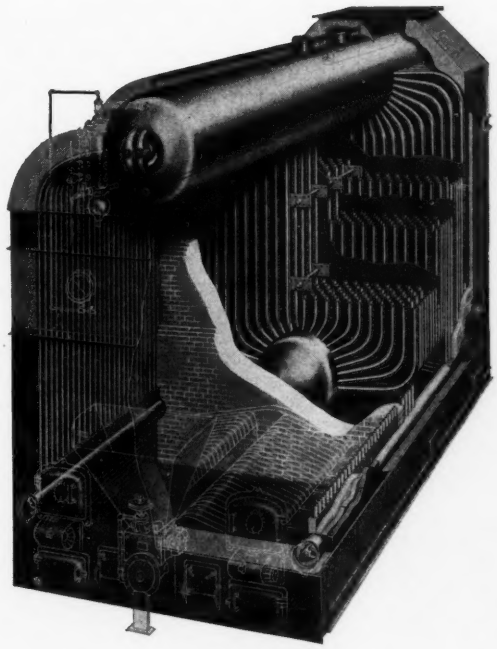


Industrial Paper Editors in Washington

Several times each year the National Conference of Business Paper Editors meet in Washington to get first hand information on government activities. The informal meetings, sometimes with the President, sometimes with other high ranking officials of domestic and foreign government agencies, are not press meetings in the strict sense of the word for there is no copy. They are confidential, and intended solely as background in interpreting the news and events. Recent meetings have been concerned primarily with the National Defense and the November 25-26 meeting ranged from Priorities to Espionage. The luncheon meeting, at which the above picture was taken, was concerned primarily with Central and South American commercial relations. This is based primarily upon encouragement of local industries on the theory that the volume of trade with well developed nations with a high standard of living is greater than with economically backward nations. Among others the editors were addressed by: Sec. of the Navy Frank Knox; Secretary of Commerce Jesse Jones; Asst. Sec. of War Patterson; Dep. Adm. of Priorities A. C. C. Hill; Asst. Dir. Edward A. Tamm of the F. B. I.; Comm. Leon Henderson of the S. E. C.; Warren Pierson, pres. of the Export-Import Bank; Major Joseph Battley of the Selective Service System; and Commissioner Smith of the N. L. R. B. Editor Turner, tied up with preliminaries to the coming A. S. M. E. meeting, was represented by President K. L. Rice (on the left at the far end of the table).

Don't Take Our Word for it–

Read What Owners Have To Say



TYPE CP
STEAM GENERATOR

- "I didn't realize how antiquated my old boiler was until I installed a Keeler CP steam generator."
- "Our fuel cost for the two years, 1938 and 1939, was $10,180 less than for the two preceding years, 1936 and 1937. Since this boiler has already paid for itself we feel that our judgment in selecting this equipment has been thoroughly vindicated."
- "I would recommend these boilers to anyone in need of high pressure boilers. We have found them to be everything that the E. Keeler Co. claimed for them."
- "These boilers have lived up to our expectations on efficiency, capacity and quick pick-up. We do not believe we could have made a better purchase."
- "We have used one of the E. Keeler Co. type CP boilers for the past three or four years and we are more than pleased with same. In fact, I am confident we are saving 15 to 25 per cent over any other boiler we have used."
- "In comparison with a heavy duty boiler we formerly had on the same job, we are saving several hundred dollars monthly; in fact, we find that it will pay for itself in a period much shorter than the engineers figured."
- "We have had two of these generators in service at our plants for the past few years and during this time have experienced nothing but the best performance. They are well constructed and the maintenance on them has been practically nothing."

(Names will be given on request)

Bulletin F-9 Will Give You Complete Data — Write Us Today

E. KEELER CO.

Builders of Better Boilers Since 1864

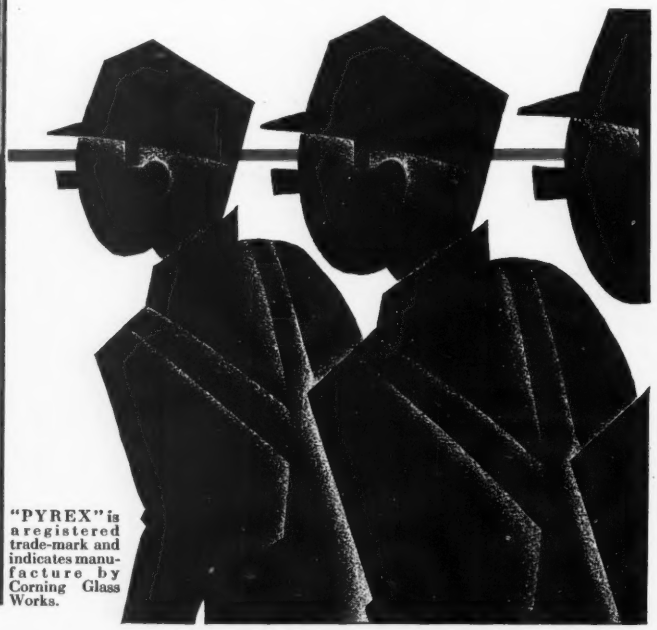
WILLIAMSPORT PENNSYLVANIA

Visibility

FROM ANY DISTANCE

Look at the illustration at the left. Here is a reproduction of a "PYREX" Broad Red Line Gauge Glass as you would see it in your boiler room from directly in front. Hold this picture at arm's length; you can't deny its visibility. Place it across the room, fifty, even a hundred feet away. As long as you can see it, you can see the liquid level.

The transparent red line of a "PYREX" Broad Red Line Gauge Glass is fused permanently into the wall of the gauge glass, combining unmatched visibility with the resistant qualities of a "PYREX" Gauge Glass. At all leading mill and steam supply dealers.



"PYREX" is a registered trade-mark and indicates manufacture by Corning Glass Works.

CORNING Glass Works Corning, New York

Pyrex Gauge Glasses

Let Us Know About It

If you have a problem on the installation or operation of power equipment, or if we can be helpful in securing latest catalogs or information from manufacturers, let us know about it. There is no charge for this service. Write Reader Service Department, POWER PLANT ENGINEERING.

Supercharging High Speed Diesels

(Continued from page 98)

through the program to some kind of a conclusion and we seriously undertook the problem of lighter weights and increased engine output at still higher speeds.

The same basic 4½ by 5¾ in. engine was selected for this purpose except that we shifted from 6 to 4 cyl. for laboratory reasons and dynamometer capacity. The 6 cylinder engine has since finished development, however, and complete data are available.

An aluminum alloy cylinder block was designed together with light weight oil pan, aluminum alloy flywheel housing, aluminum cylinder heads and manifolding and in this connection the Research Department of the Aluminum Company of America has contributed largely to our progress.

Bearing sizes and cranksize were entirely adequate but in order to reduce reciprocating weight, the piston was redesigned and considerably lightened, the connecting rod was reduced about 30 per cent in weight and the wrist pin was reduced in diameter from 1¾ to $1\frac{7}{16}$ in.

This engine complete as a marine design with fresh water closed cooling system, reversing gear, raw water pumps and all electric starting accessories develops 160 hp. at 2400 r.p.m. A stripped automotive engine embodying this construction weighs 1120 lb. which amounts to 7 lb. per hp. This design has had nearly 5000 hr. in the laboratory and is being made ready for production during 1940.

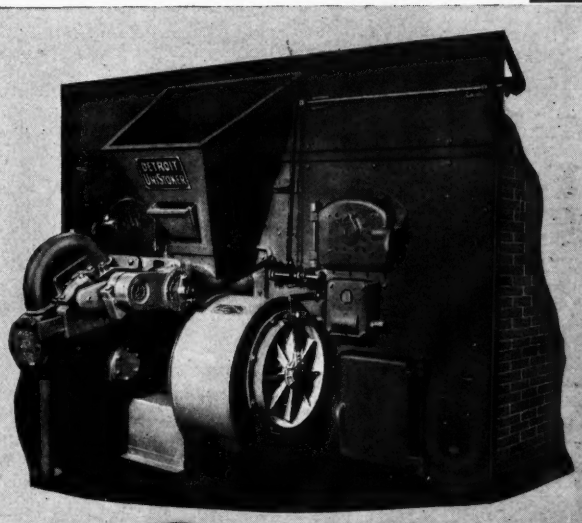
Thus we see that in 1920 an engine classified as high speed and high output weighed 100 to 150 lb. per hp. and turned between 300 and 500 r.p.m. while in 1940 it is built well under 10 lb. per hp. and can turn 2400 r.p.m. as reliably as any gasoline automotive truck engine. That period of time represents nearly half the total age of the Diesel engine.

It is not intended here to name any limitation on maximum speeds of operation. About 2400 r.p.m. represents the top commercial speed of an engine of 4½ by 5¾ in. cyl. size but there is no reason whatever to indicate that peak speeds of 3500 or 4000 are not yet just as practicable in an engine of smaller cylinder displacement. It is only one step further, and so far as supercharging, combustion phenom-

(Continued on page 128)

FORESIGHT

CALLS FOR EXTRA DEPENDABILITY



Buy a DETROIT UNISTOKER

It costs money to provide aviators with parachutes, but no one questions the wisdom of doing it. The extra safety is well worth the investment.

You can buy cheaply built stokers for less money than you pay for Detroit Stokers, but foresighted buyers find them well worth the additional cost.

Detroit Stokers have the extra dependability that assures low maintenance service over a long period of years—many more years than you can expect of a stoker built down to a price.

All Detroit Stokers are plunger feed—mechanically driven, requiring little power for operation. Grate surface parts are of high heat resisting iron for long life.

Thousands of satisfied users.

WRITE FOR BULLETIN
No. 624

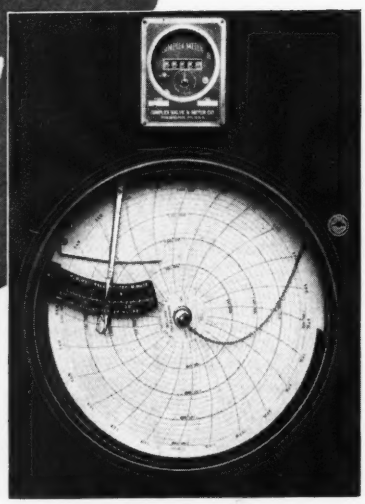
DETROIT STOKER COMPANY

Sales & Engineering Offices
General Motors Building
Detroit, Michigan

Main Office and Works
Monroe, Michigan
Built in Canada at London, Ont.

District Offices in Principal Cities

This Watchdog Puts STEAM-WASTERS on the Spot



Always on the job, always accurate, Simplex Venturi Type Meters keep you constantly posted on the steam requirements of all plant equipment. They serve as a money-saving combined watch-dog and bookkeeper.

Compact in design and built for wide range service, these Simplex Meters are widely used for Boiler Feed, Steam Condensate or Evaporate flow measurement.

SIMPLEX TYPE MS METER

Furnished in any size and for operating pressures up to 2500 lb.

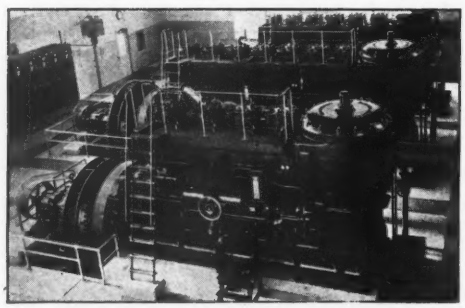
Write for Bulletin No. 52.

SIMPLEX VALVE & METER CO., 6790 Upland St., Philadelphia, Pa.

SIMPLEX METERS

NUGENT DUPLEX FUEL OIL FILTERS

—A Good Investment for Any Diesel!



• *The three big Fairbanks-Morse Diesel Engines shown at the left are installed in the light plant at La Junta, Colo., and are equipped with Nugent Duplex Fuel Oil Filters.*

THE Nugent Duplex Fuel Oil Filter is not just an ordinary filter. It's a specially designed patented unit built to meet the demands of Diesel operators who can't take a chance on power interruptions. It has 20 times more actual filtering area than most filters of comparable size, which means a 20 times longer interval between cleaning. The duplex construction makes it easy to maintain continuous protection year after year. Units are offered in 5 sizes. Get our recommendations. Ask for Bulletin 7A.

NUGENT TRADE MARK

Wm. W. Nugent & Co., Inc. Mfrs.

Oil Filters, Oiling and Filtering Systems, Telescopic Oilers, Oiling Devices Sight Feed Valves, Flow Indicators, Compression Union Fittings, Oil Pumps, Etc.

423 N. HERMITAGE AVE. Established 1897 CHICAGO, U.S.A.

Helpful Bulletins

BOILER PLANT EQUIPMENT

1 Water Tube Boilers—Erie City Iron Works has issued an 8-page bulletin, "Some Recent Water Tube Boiler Installations". Contains performance data and sectional views of five noteworthy boiler jobs.

2 Moving Grate Stoker—New 6-page illustrated bulletin describes Detroit C-D single retort, moving grate stoker for boilers of 300 to 500 hp. The moving grates are hollow, air cooled, and air passing through them is preheated. Detroit Stoker Co.

3 Deaerating Heaters — Cochrane Corp. illustrated Bulletin No. 2965, entitled "Deaeration By Atomization," tells about the increasingly important atomizing principle in deaerating heater construction. Also includes tables showing how these modern heaters perform under all load conditions.

4 Stoker—New illustrated folder describes construction features and boiler applications of Bros super-speed stoker. Also contains sectional drawing of compact Bros stoker-boiler unit. Wm. Bros Boiler & Mfg. Co.

5 Boiler Tube Plug—Hardie Made-Rite Boiler Tube Plug Co. has issued a 14-page booklet indicating how boiler tube plugs are inserted to prevent shutdowns and loss of power. Types are provided for water-tube and fire-tube boilers.

6 Refractories — "World-Wide Refractories Service" is the title of a 48-page export booklet, with 65 drawings of brick shapes and sizes. It covers descriptive information on all the major types of refractories and their uses, methods of shipment for export, and incorporates ten pages of such tables of sizes, weights, volumes and general data as are usually required in the use, application and purchase of refractories. General Refractories Co.

7 Coal Handling — New 56-page Sauerman Coal Handling Catalog shows many installations and gives approximate cost figures for various coal handling jobs. Sauerman Bros., Inc.

8 Stoker — New illustrated folder, "Here's How To Cut Coal Costs" describes operating features of Fyr-Feeder stoker. Also lists actual performance records of this modern coal-burning system in eighteen different plants. American Coal Burner Co.

ELECTRICAL EQUIPMENT

9 Rubber Covered Cable—Well illustrated 36-page catalog describes Roebling's new "thin-wall" rubber covered wires and cables, service entrance cables. Also contains dimension tables and other useful information for electrical men. John A. Roebling's Sons Co.

10 Generators For Diesels — Burke Electric Co. has issued a 4-page illustrated bulletin describing Burke A.C. synchronous generators for Diesels. Drawings show advanced construction features of core assembly, rotor and other parts. Capacities range from 31 to 1500 kv.a.

11 Circuit Breakers — Recently released, Bulletin 4009 entitled "Air Switchgear for 2500-5000 Volt Duty Utilizing Type HV Circuit Breaker," fully illustrates and describes HV air breakers for steel enclosed switchboards. I-T-E Circuit Breaker Co.

55 **"Boiler Water Impurities and Their Control"** is the title of a 34-page pocket size handbook containing a complete discussion of boiler-water troubles, boiler water impurities and instructions for maintenance of the standard boiler water condition. Solutions are recommended for the problems of concentration, priming, dirty steam, scale and corrosion. Henszey Company.

56 **Silica Removal**—Permutit Co., 8-page bulletin No. 2377 describes low-cost process, "Mag-de-Sil," for silica removal, without appreciable increase in total dissolved solids. Bulletin is summary of high points of research program made by company.

57 **Water Conditioning**—Elgin Softener Corp. 16-page booklet entitled "The Inside Story of Boiler Water Conditioning", explains wide variations in boiler-feed waters and operating conditions; how impurities accumulate inside a boiler and how they can be eliminated; and tells how to maintain ideal boiler-water conditions inside a boiler by using correct treating and conditioning system.

MISCELLANEOUS

58 **Electric Hoists**—Whiting Corp. has issued two bulletins telling about the application of electric hoists to a wide range of material handling jobs in power plants and other industries. Type WF electric hoist with push-button control has a capacity of 1000-15,000 lb. Type WS hoist is pendent rope controlled.

59 **Building Maintenance**—A new 74-page "Handbook of Building Maintenance" has just been issued by the Flexrock Co. It contains practical information for factory engineers and maintenance men, shows how to do hundreds of odd jobs with better results and at lower cost. More than 150 pictures, diagrams and drawings.

60 **Industrial Humidifiers**—Data book information on humidification requirements for various types of processing operations and for storage of different types of material is contained in a new 8-page bulletin describing Armstrong Steam Type Humdifiers. Armstrong Machine Works.

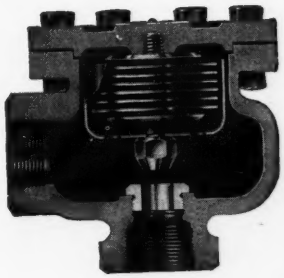
61 **Oil Filters**—Filters for removing dirt particles from oil used in lubricating Diesel engines, turbines, and other prime movers; filters for installation on the fuel supply lines of Diesel engines and oil burners; and filters for removing solids from coolants used on grinders and automatic screw machines are all described in bulletin No. 7A published by Wm. W. Nugent Co.

62 **Cooling Tower**—Marley Co. 4-page bulletin No. 202 gives design, construction, specifications and features of new size cooling tower, offered at special low price. Capacity in tons of refrigeration presented.

63 **Gaskets**—New 64-page gasket handbook gives valuable data on gaskets, packing and other modern fluid seals. It includes technical data, lists new products and gives complete size and price information. Goetze Gasket & Packing Co.

64 **Emergency Repairs**—A guide to the use of Smooth-On Cements tells how pipelines, boilers, cylinders, stripped threads, loose bolts and similar equipment can be quickly and easily repaired, leaks stopped and loose parts firmly anchored. Smooth-On Mfg. Co.

EXTRA CAPACITY *Steam Traps* By NICHOLSON



WELDED FLOATS FOR HIGH PRESSURE SERVICE

"Nicholson" Welded Floats are available in spherical and elliptical shapes in sizes from 2½" to 14" diameter—in stainless steel and in chromium plated steel. Made for all steam pressures up to 1500 lbs. and hydrostatic pressures up to 2500 lbs.

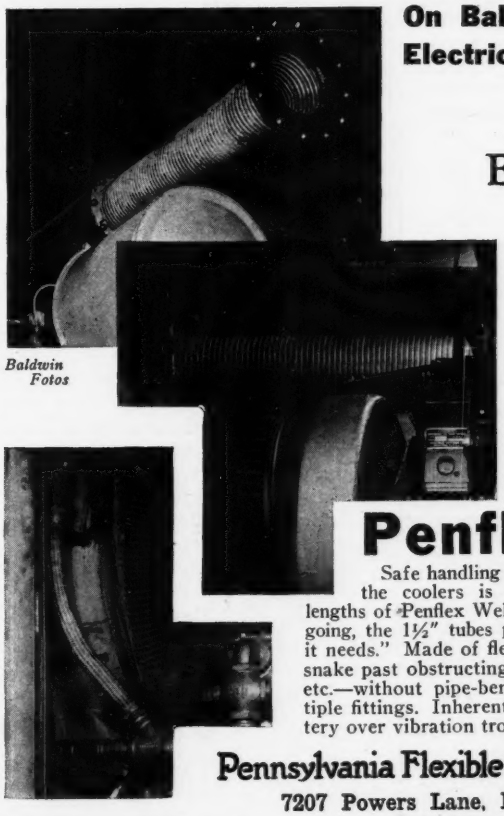
They are die formed—not spun or laminated—with welding seam serving as reinforcing ring and give extraordinary resistance to external pressure. Available also with cadmium, nickel or copper plating. Write for Bulletin No. 339 covering details.

These sturdy traps are tops in value because they have from two to six times more capacity than average traps. They are non-air-binding and non-freezing, require no adjustment, work on pressures up to 300 lb.

Nicholson Traps employ temperature difference between steam and condensate to open and close their valves; a heavy-duty thermostatic bellows with brazed-end plates serving as the operating mechanism.

Available in Bronze, Cast Iron and Cast Steel construction in sizes ¼ to 2 in. Specify Nicholson Traps regularly for improved drainage of Unit Heaters, Pipe Coils, Water Heaters, etc. Write for Steam Trap Catalog No. 240.

W. H. NICHOLSON & COMPANY
160 OREGON ST. WILKES-BARRE, PA.



Baldwin Fotos

On Baldwin Diesel-Electric Locomotives

PENFLEX Exhaust Pipes

The flexibility that makes Baldwin exhausts so safe is shown in the assembly and ready-to-run fotos at left. No strain on fittings when steel 4-wall, interlocking joint Penflex is used.

. . . also

6 Safe Steel Lube Lines

Penflex Weld

Safe handling of lubricating oil to and from the coolers is assured through use of 6 lengths of Penflex Weld. No matter how rough the going, the 1½" tubes pictured at right "have what it needs." Made of flexible corrugated steel, they snake past obstructing engine parts, etc.—without pipe-bending or multiple fittings. Inherent is their mastery over vibration troubles.

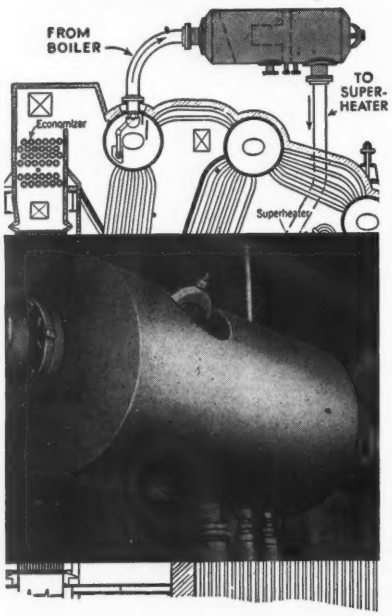
Write for Bulletins 70 and 90

Pennsylvania Flexible Metallic Tubing Co.
7207 Powers Lane, Philadelphia. Pa.

Extra Capacity—

from Over-Loaded Boilers with

COCHRANE STEAM PURIFIERS



Here's one plant . . . that increased capacity 270% of boiler rating . . .

In a large process plant an average of 194% of boiler rating was required but 150% could not be exceeded without excessive carry-over. Cochrane Purifiers were installed and the desired conditions readily attained—a 96-hour test gave perfect results at 270% of boiler rating.

Cochrane Steam Purifiers eliminate practically all moisture and solid impurities from steam, protecting and increasing the efficiency of superheaters, turbines and other equipment.

Technical data and case studies are described in our Publication 2725. Write:

COCHRANE SEPARATORS

COCHRANE CORPORATION
3123 N. 17th Street, Philadelphia, Pa.

COCHRANE

Cochrane Corp., 3123 N. 17th St., Phila., Pa.
Please send me a copy of your Publication 2725 on Steam Purifiers.

Name.....
Firm.....
Address.....
City..... State.....

Supercharging High Speed Diesels

(Continued from page 122)

ena and physical materials are concerned, there seems to be no obstacle. Our present interests are in engines of 4½ in. bore upward but the automotive engine builder can readily achieve higher speeds through smaller displacement.

An item of special interest is the air cooler between the supercharger and engine. This heavy duty core type air cooler uses the raw water for cooling and compressed supercharged air before it reaches the engine cylinder and it greatly increases the air density resulting in substantial gain in power. Our Research Department spent a considerable time in testing and developing a cooler of sufficient capacity in collaboration with Young Radiator Co. and Fig. 4 shows the effect of the air cooler on performance.

The supercharger itself has undergone considerable evolution. The design now being put into production is streamlined and jacketed and is quite noiseless when properly air silenced. It is thoroughly reliable and little or no maintenance is required. Fig. 5 shows the supercharger data and boost pressures and Fig. 3 shows the 6 cyl. performance. Figure 6 shows comparative supercharge and unsupercharge curves on the 6 cylinder engine.

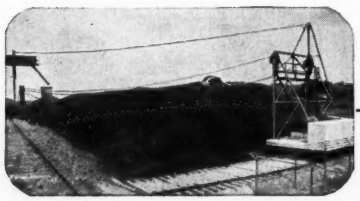
The Future

It seems quite conclusive that the high output, high speed four cycle supercharged Diesel engine can be built today on a production basis in very close cost equality with the gasoline engine. The automotive type Diesel power plant of the future may in all probability be a smaller displacement engine than its gasoline burning competitor and about the same weight per horsepower but it will have better economy. Supercharging to the Diesel engineer opens up the same possibilities for progress as the advent of superheated steam and high pressure steam offered the steam engineer and it seems likely from our experience that 200 lb. b.m.e.p., 4 cy. may ultimately be attained in a commercial engine.

At the present time higher b.m.e.p.'s are attained in aircraft engines for take off where fuel economy is secondary. Similarly aircraft Diesel engines are built in much lower weight per horsepower than the weights indicated herein.

SAUERMAN

Power Scrapers



Store Coal for 3c per Ton

Yes, thousands of tons of coal are moved every day at costs of 3c per ton and less, at hundreds of power plants (like the above) equipped with Sauerman Power Drag Scrapers. Economy, however, is only one of the merits of this system of storing and reclaiming coal. Simple, automatic operation is another feature. And very important is the fact that a coal pile made with a scraper is tightly packed and offers no chance for spontaneous combustion.

Write for Catalog!

SAUERMAN BROS., Inc.
486 S. CLINTON ST., CHICAGO, ILL.

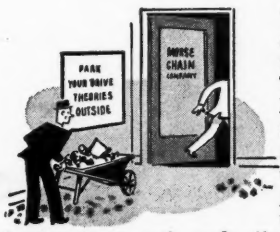
Guide Posts To Buying

Reading the advertising messages that appear in POWER PLANT ENGINEERING is a profitable habit to acquire. They provide the latest information on what's new and useful in the power plant market. They serve as dependable guide posts to buying.

Park your Drive Theories Outside

•

AND LEARN ABOUT MORSE ENGINEERED HIGH SPEED DRIVES



TRADITIONAL chain speed limits have been tossed out the window. Tossed out because some Morse engineers decided not to accept the old rules, and went ahead to find out what happened with drives which used larger sprockets having more teeth, and mile-a-minute chain speeds.

The results amazed even the engineers, pointed out a whole new series of facts on which to plan efficient, economical chain drives.

Centrifugal force, said the old beliefs, ruined the practicability of chain drives operating at speeds above 3,000 feet per minute. This seemed logical because of experience with other forms of drive using pulleys where additional tension is required at speeds above 3,000 feet per minute to offset the loss of "grip" due to centrifugal force.

"Teeth Not Tension" changes the whole picture.

Research in laboratory and field, carried on by Morse engineers for several years using larger sprockets with chain speeds zooming up to almost 8,000 feet a minute, has resulted in some new concepts of chain drive engineering. As sprocket sizes are increased, thus stepping up chain speed, the ability of the chain to transmit power increases tremendously, and unbelievably silent operation results. Since centrifugal forces do not cause loss of traction because of driving over teeth, they need not be considered as additional forces to the working load when within working limits of stress. Working loads can be increased at high chain velocity because of the tapered nature of load application, and maximum drive efficiency is realized when chain velocity reaches the point where centrifugal load equals working load.

Since, in a well-designed high speed drive, joint wear and consequent pitch elongation are practically eliminated, drives may operate on fixed centers. Even distribution of driving forces over nearly all teeth in contact makes sprocket wear slight, practically disappearing when teeth are heat treated.

With practically noiseless operation and simple lubrication made possible by the new Morse "wave" principle, bearing loads reach a new low with absence of drive tension and greatly reduced drive width.

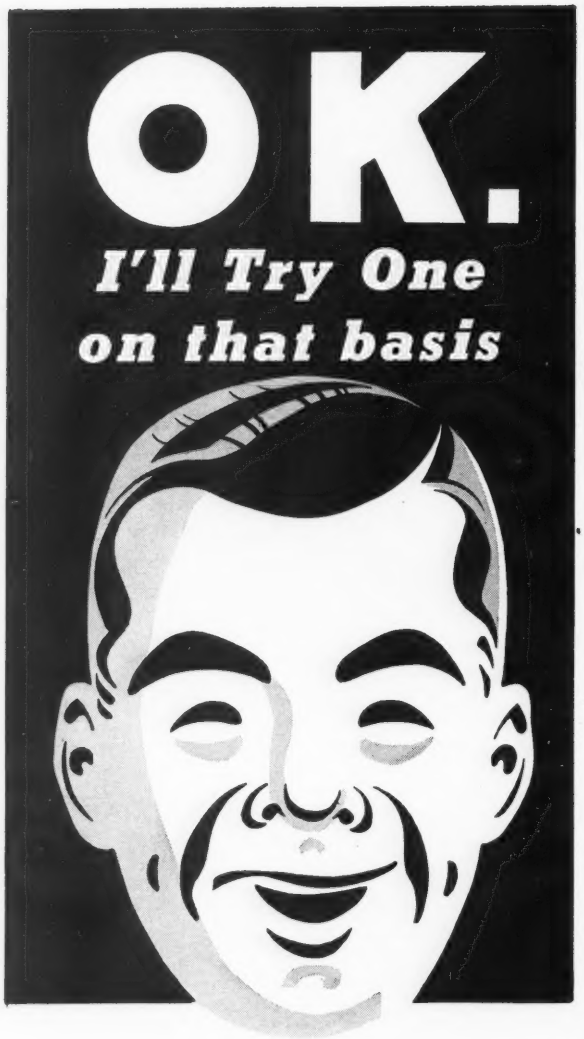
The largest field for these drives is where ratios are from 1:1 to 4:1, and rotative speeds from 400 to 4,000. These drives have efficiencies up to 99.4% and insure noiseless operation, long and trouble-free life, greatly reduced bearing loads, and minimum space requirements.

The Morse chains and sprockets are carried in complete stocks in many cities throughout the country. Get in touch with the Morse man, and learn how Morse service continues to improve.

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N.Y. DIVISION BORG-WARNER CORP.



Install a Dart anywhere in your plant . . . *at our expense.* That's the surest way to prove *without question,* that Dart unions do a real job, assure quick, easy tightness when installed; permanent, trouble-proof tightness in service.

We can afford to make an offer like this because Darts make good consistently. They go in and stay tight the first time. And what's more, due to their precision-ground, bronze-to-bronze seats, they can be re-installed again and again, tight as when new. So if you want *more for your money* in pipe unions, give Dart a try. Just specify size and model. A post card will do the trick.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

News from the Field

A. G. Solomon

AXEL G. SOLOMON, a noted refrigerating engineer and long time contributor to POWER PLANT ENGINEERING, died at his home in Bradbury Heights, Md., on November 29, 1940.

Mr. Solomon was born in Chicago, Ill., in 1880. His first job was with Armour and Company, where he started in the boiler room at the age of 15. Armour sent him to Ft. Worth, Texas, to take charge of their power plant there as chief engineer before he was 21 years old. He obtained his first engineer's license at that time.

He was chief engineer for Wilson & Co. for a number of years and spent ten years with the Public Service Co. of North Carolina. Later he went to Washington, D. C., where he did consulting work on air conditioning until his health began to fail about two years ago. He is survived by a widow and three sons.

William A. Moore

WILLIAM ALVIN MOORE, 37, Vice President and General Sales Manager of Mississippi Power & Light Co., at Jackson, died Monday after an illness of two weeks. He had recently been appointed Co-ordinator of Industry of Mississippi with the rank of Lieutenant Colonel and Intelligence Officer in the state militia department. After graduating with high honors in 1924 he was selected by the General Electric Co., for an advanced course in engineering sales training and special test work and remained with the company until coming with the Mississippi company where he was made Vice President in 1937.

Wilbert J. Austin

WILBERT J. AUSTIN of Cleveland, who was among the victims in the airliner which crashed at Chicago December 4, had been president of The Austin Co. since 1924. As active head of an enterprise which designed and erected nearly 6000 industrial buildings, Mr. Austin was known to business executives throughout the world as an advocate of functionalism in factory building.

A native of Cleveland where his father, Samuel Austin, set up as a journeyman carpenter on arrival from England in 1873, Wilbert Austin was graduated from Case School of Applied Science in 1899 with a Bachelor of Science degree in Mechanical Engineering. In March, 1940, this school awarded him an honorary degree of Doctor of Engineering.

In 1900, after a year's travel and study abroad, Mr. Austin joined his father who had already developed a substantial following as a builder of residential, commercial and industrial structures. While he had relinquished the responsibilities of general manager some years ago, at the time of his death Mr. Austin was devoting his principal attention to the construction needs in the present emergency.

Mr. Austin, 64, was a trustee of Case School of Applied Science, past president of its alumni body and chairman of its building committee, as well as a member of the Y. M. C. A. national council. He was a member of the New York Bankers' Club, the Detroit Yacht Club, Highland (Florida) Club, the Cleveland Engineering Society, and the Union Club and Shaker Heights Country Club of Cleveland.

Virginia Public Service Co.

VIRGINIA PUBLIC SERVICE CO., Alexandria, Va., has approved plans for expansion of its local steam station, to include a turbine-generator unit, high-pressure boiler and auxiliary equipment. The turbine unit will have a rated capacity of 15,000-kw., and will be furnished by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; contracts for other required equipment will be placed soon. Work on the project will proceed early in 1941, with completion scheduled about 12 mo. later. Cost is estimated close to $2,000,000. The company also plans extension and improvements in high-tension transmission lines, including a tie-in connection with the lines of the Virginia Elec. & Power Co., Richmond, Va., at Occpquan, Va.

COLUMBIA MISSOURI
Saves $25,000 yearly in fuel cost alone
READING-PRATT & CADY
Cooperating with hydro...
Cut MAINTENANCE Cost
New Kraft Mill Uses READING-PRATT & CADY to Solve Valve Problems
For PRECISE, CLOSE CONTROL TRY BAR STOCK VALVES IN YOUR PLANT
A COCK THAT BOTH ENGINEERS AND PLANT MEN WILL OK.
READING-PRATT & CADY
AMERICAN CHAIN & CABLE COMPANY

"Interest"—

You will find real interest in a recommendation from Reading-Pratt & Cady whenever the solution of your problem involves the selection of valves.

You can read that two ways—because the recommendation itself will show you our sincere interest in working with you.

Part of the Record of Power Plant Development

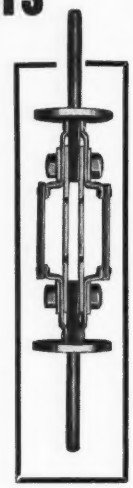
The advertisements on this page show the results of Reading-Pratt & Cady's interest in developing valves for Power Plant application. It led Pratt & Cady to develop such things as Lubrotite Gate Valves, Swing Check Valves, Bar Stock Valves, Asbestos Packed Cocks. It led Reading, over twenty years ago to pioneer pressure steel castings that make it possible for you today to handle high-pressure high-temperature steam.

Remember this when you have a problem that concerns valves. Be sure to get a recommendation from Reading-Pratt & Cady.

READING-PRATT & CADY
DIVISION · · READING, PENNSYLVANIA

AMERICAN CHAIN & CABLE COMPANY, Inc.

100% PROTECTION FOR YOUR CIRCUITS



Decide now to do away with the bother and expense of old-style fuses — specify WARE HI-LAG Fuses on all your plant circuits for maximum protection at minimum cost.

These improved WARE HI-LAG Fuses provide an extremely **high time lag** which ends the blow-outs often caused by starting motors and momentary surges.

Then, too, their new **double-bridge** assembly is easier to renew correctly than to overload. Only one end of casing is removed. Assembly may be inserted either end first. Other advantages include Spring Tension Contacts, One Piece Flat Link.

WARE BROTHERS, 4500 Lake St., CHICAGO

Double Capacity of Venice Plant

UNION ELECTRIC Co. of Missouri, Inc., St. Louis, Mo., has plans maturing for a new steam station at Venice, Ill. Work is now in progress on a 80,000-kw. section and new addition will duplicate this capacity. Each section will include two 40,000-kw. turbine-generators, high-pressure boilers and auxiliary equipment. The current project will require from 8 to 10 mo. for completion, and will represent a total investment of close to $11,000,000, including switchyard structure, power substation units, transmission lines and other operating facilities. The new extension is estimated to cost approximately $7,500,000 and work will be placed under way early in 1941, with completion during the spring of 1942.

P. G. & E. Defense Plans

NATIONAL DEFENSE is estimated by the Pacific Gas & Electric Co. to add about 60,000 hp. in capacity requirements to the system. Of this, about 50,000 hp. is for military establishments and about 10,000 hp. for industrial plants including three ship building firms in the Bay region. The P. G. & E. system with 49 hydroelectric and 9 steam generating stations now has a total capacity of 1,757,797 hp. In addition to this, the company purchases power from nine different sources and takes delivery of consigned power from the Hetch Hetchy development.

To this extensive system, the company is now adding four generating plants with a total capacity of approximately 230,000 hp. at a cost of approximately $19,000,000. Three of these new stations are steam stations of 67,000 hp. adjacent to the Tide Water Associated, Shell Oil, and Union Oil Refinery. Construction and arrangement of these stations are described in an article on page 71 of the October, 1940, issue. Of the total of 201,000 hp. in these three stations, approximately 31,000 hp. will be required for industrial use and the balance of 170,000 hp. will be available for the system network.

The fourth new station will be a 28,000 hp. hydroelectric generating plant at Dutch Flat on the Bear River in Nevada County. The station will cost $3,210,000 exclusive of an outlay of $570,000 for transmission lines. Preliminary work started last month and the project is expected to be completed in about 2 yr.

In addition to this new capacity, the company is spending more than a $1,000,000 to double the capacity of its tie links with the Southern California Edison Co. so as to make available a capacity of about 200,000 hp. from this source.

W. P. S. Corp. 1941 Budget Sets New High

CONSTRUCTION budget of Wisconsin Public Service Corp. for 1941, amounting to $4,478,000, was approved recently by the board of directors, according to an announcement by J. P. Pulliam, president, who pointed out that this is the largest construction budget in the history of the corporation's operations.

Mr. Pulliam stated that much of the contemplated expenditure was occasioned by consideration of national defense problems. Included in the budget are contemplated expenditures of $2,640,000 for an addition to the Bayside steam generating plant at Green Bay; $100,000 for an interconnection with the electric system of Wisconsin-Michigan Power Co.; $262 000 for an additional transmission line between Green Bay and Manitowoc; $245,000 for other transmission and substation additions; $387,000 for additional urban and rural electric service extensions; $120,000 for additions and improvements to gas plants and gas main systems; $105,000 for a new office building at Wausau.

Hauto Station Expansion

PENNSYLVANIA LIGHT & POWER Co., Allentown, Pa., has authorized plans for an addition to the steam station at Hauto, near Mauch Chunk, Pa., to increase the capacity from 75,000 to 100,000-kw. This will include a new 25,000-kw. turbine unit and accessories; high-pressure boilers and auxiliary equipment. Work will be carried out as part of 1941 expansion program of company and is scheduled to be completed early in 1942. The cost is estimated at close to $5,000,000, including extensions in the switchyard structure, transmission lines and power substation facilities. The company now has work in progress on its Cedar Stream steam-electric generating plant at Harrisburg, Pa., where the capacity will be increased by 30,000-kw. This expansion is expected to be completed early in 1941.

Spray-Spred FIRING METHOD

EXCLUSIVE WITH Fyr-Feeder

IS REVOLUTIONIZING COAL BURNING . .

NOW A TWO UNIT Fyr-Feeder

MODEL R 4072
200 D. H. P. CAPACITY

Only $995
F. O. B. FACTORY
CONTROLS EXTRA

OTHER SIZES IN PROPORTION

Sets a new high in Cost Savings

The Multiple FYR-FEEDER Stoker has changed complicated boiler firing to *simplicity itself.* Exclusive, proved, efficient features—few working parts, all slow-moving—most effective, dependable design—new economy that materially cuts former coal burning costs.

Here's how each FYR-FEEDER unit works.—The coal is drawn mechanically from a large hopper to inclines inside the furnace. The coal then rolls down these inclines into air streams under light pressure. Thus, coal is "air-cleaned" and coal dust is "sprayed" and instantly burned in suspension by the air which sprays it. The balance of the coal is spread along the length of the forced draft grate according to weight-size of each piece.

Fire cleaning is easy and takes only a few minutes. FYR-FEEDER Stokers are always built with *two* or *more* individually-controlled FYR-FEEDER Spray-Spred units so that coal feeding on one side of the grate can be stopped, permitting the coal on that side to burn out completely before cleaning or dumping the ashes from that side of the grate. While cleaning fires on one side, *the feeders on the other side are* SPRAY-SPREDing coal to maintain steam pressure.

Spray-Spred capacity of each unit varies according to size and speed and will deliver and Spray-Spred coal up to as much as 500 developed horsepower per unit. Thus, 10 FYR-FEEDER units can be supplied to handle a 5000 horsepower load. Grates may be Stationary, Dumping or Chain Grates (where continuous ash removal is wanted). FYR-FEEDERS may be set directly over fire doors or as much as 10 feet or more above grates.

Learn what the Multiple FYR-FEEDER'S *simplicity and most natural way of firing coal* will do for you. Many hundreds of these FYR-FEEDER Spray-Spred units are proving daily that the best and simplest way to fire any boiler efficiently is to fire coal by SPRAY-SPREDing it over a forced draft fire on a grate.

AMERICAN COAL BURNER COMPANY
155 E. Superior St., Chicago, Ill.
Builders of Over-feed Stokers for Over 22 Years

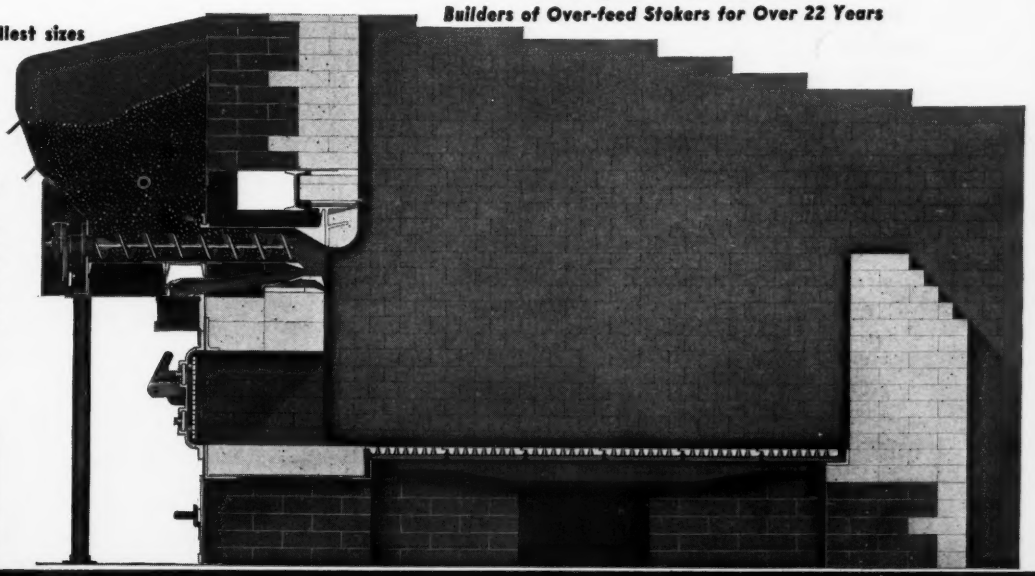
Fyr-Feeder SIMPLICITY
gives you many benefits

- instantaneous ignition of fines
- air spray spreads the coal over grates
- less power to operate
- lower maintenance costs
- reduced steam costs
- burns lowest price coal and smallest sizes
- fires cleaned quicker
- banking losses reduced
- readily adaptable to various types of boilers

AIR-CLEANING all of the coal, inside the furnace, insures a freer air supply to the coal being burned on the grates.

In the FYR-FEEDER furnace, two distinct combustion zones are maintained—one for burning the larger pieces of coal, and one for burning the fines and dust in suspension, each with its own individual, separately-controlled air supply.

Get all the Facts
WRITE TODAY

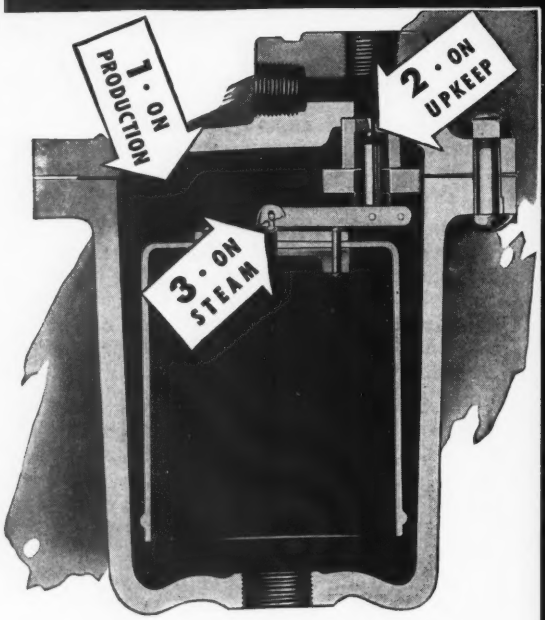


Spray-Spred
MULTIPLE **Fyr-Feeder**

REDUCES COAL BILLS - - BURNS CHEAPEST COAL SIZES

PIPEWRENCH PETE SAYS:

THESE 3 SAVINGS MAKE SENSE TO ME!



1 Cut down spoilage, keep production UP! Strong's positive-acting, extra-capacity traps often increase output amazingly — always keep costs DOWN!

★ ★ ★

2 Strong traps just don't seem to wear out! That special, wear-resisting Anumetl makes STRONG valves and seats last eight times as long as even Strong's former parts. You get a full year's guarantee against valve leakage or any replacement.

★ ★ ★

3 How much can positive opening and tight closing of your traps save on steam? Get these savings with STRONG'S *anti-balancing* device! Valve opens wide to discharge condensate, then closes tight—no dribbling! Positive action, plus Anumetl valves and seats can easily save more than the trap costs, in steam alone.

★ ★ ★

MONEY-BACK GUARANTEE! Test Strong traps on your toughest jobs. If not satisfied at the end of 90 days, return them, and your money will be refunded.

HOW DO YOU SIZE STEAM TRAPS? An easy method, plus valuable information on installations, etc. Get Catalog 63-PE2

THE STRONG, CARLISLE & HAMMOND CO.
1392 WEST THIRD ST., CLEVELAND, OHIO

STRONG
STEAM TRAPS

Louisiana Engineering Society to Meet

At the St. Charles Hotel in New Orleans, the Louisiana Engineering Society will hold its 1941 annual meeting on January 10 and 11. In addition to a technical program including several papers by engineers of nation-wide reputation, a varied program of inspection trips and social features have been provided.

F. G. Frost will speak on the History of Electrical Industry in United States and Its Influence on National Defense. E. G. Bailey, of The Babcock & Wilcox Co., will speak on the New Technique in Boiler Design, and Dr. F. E. Giesecke of American Society of Heating & Ventilating at the Agriculture & Mechanical College of Texas, will speak on Radiant Heating and Cooling.

Other papers include the Science of Seeing by Dr. Matthew Luckiesh of the General Electric Company. Solving the Dust and Dirt Problem Electrically by S. R. Orem, Jr., of the Westinghouse Electric & Mfg. Co. The Process in Creosoting Wood by Charles M. Kerr of American Creosote Works, Inc.. and Problems in Steel Construction by Mace H. Bell of the American Institute of Steel Construction.

Midwest Power Conference

Announcement has been made that the Fourth Midwest Power Conference will be held April 9 and 10 at the Palmer House in Chicago. This conference is sponsored annually by the Illinois Institute of Technology with the cooperation of seven other midwestern universities and colleges and the local sections of the Founder and other engineering societies. (The Illinois Institute of Technology is a consolidation of Armour Institute of Technology and Lewis Institute.)

The tentative program includes sessions on central station practice, stationary prime movers and plant auxiliaries, hydro power, electric power transmission and distribution, feedwater treatment, and industrial power plants, including interchange contracts between industrials and utilities. In addition, there will be joint luncheons with the Chicago Sections of the A.S.M.E. and the A.I.E.E., an All-Engineers' Dinner, and inspection trip, and a smoker.

Inquiries regarding the conference should be addressed to Stanton E. Winston, Conference Director, or Charles N. Nash, Conference Secretary, Illinois Institute of Technology, 3300 Federal Street, Chicago, Ill.

Engineering Defense Training

North Carolina State College of Agriculture and Engineering, University of North Carolina, Raleigh, N. C., has announced 15 special courses in engineering defense training. These courses scheduled to begin shortly after the first of the year, range from 4 to 20 wk. The Federal Government pays the full cost of tuition for approved students, but not for room and board, which is estimated by the university at from $65.00 to $80.00 for a 12 wk. course.

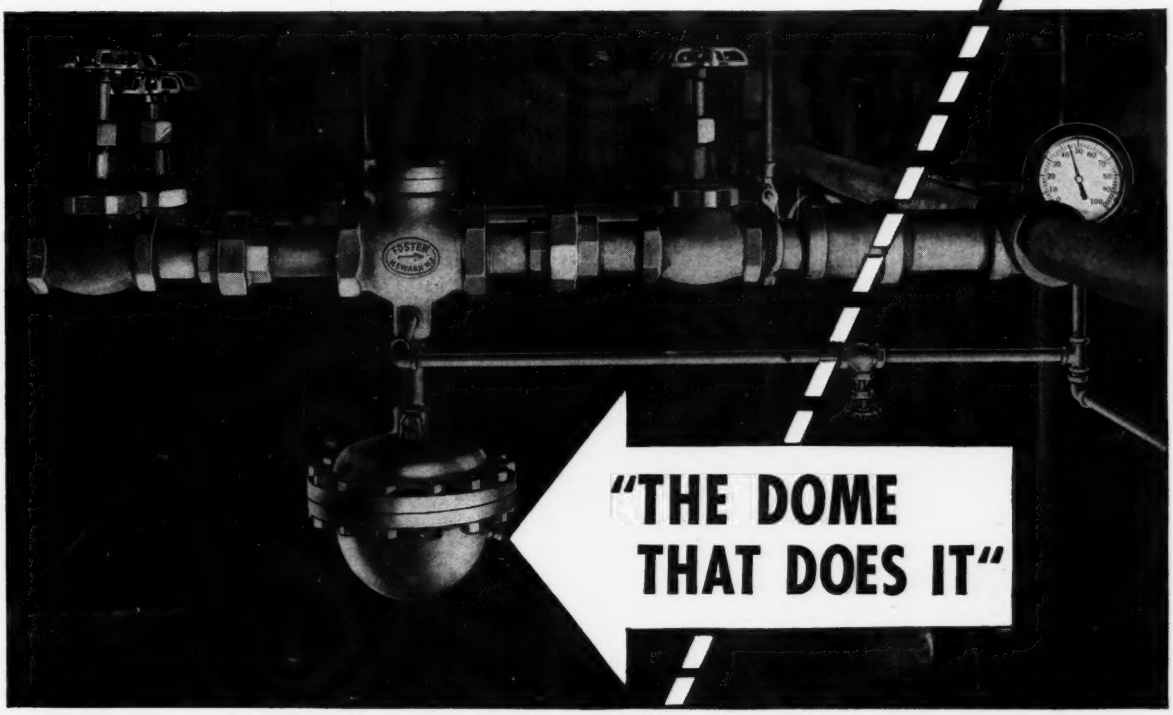
Courses offered include: Aircraft Inspection; Airplane Power Plants; Airport Design; Chemical Testing and Inspection; Diesel Engineering; Engineering Drawing; Experimental Electronics; Instrument Men and Topographers; Military Cryptography and Cryptanalysis; Materials Inspection and Testing; Physical and Reduction Metallurgy; Production Engineering; Production Supervision; Machine Design, and Spectroscopy in Industry.

Further information can be obtained from Edward W. Ruggles, Director, Engineering Defense Training, North Carolina State College, Raleigh, N. C.

Bids Soon for Pumping Stations

The U. S. Engineer Office, Huntington, W. Va., has plans nearing completion and will take bids early in 1941 for two large pumping stations in connection with flood control work, forming a section of what is known as the West flood wall. The plants will be located at points designated as Four-Pole Creek and Krouts Creek, respectively, and will augment four pumping stations now in course of construction. The first noted station will be equipped with electric-operated pumping units with maximum capacity of 540,000 g.p.m. min., while the Krouts Creek plant will have a rating of 25,000 g.p.m. The entire project will include the construction of dams at both places and is estimated to cost about $1,000,000. The Pitt Construction Co., Inc., 1235 Washington Boulevard, Pittsburgh, Pa., has the contract for the four pumping plants now under way.

If pressure regulation is your problem, investigate



Typical installation of a Foster Type 39-Q1 Pressure Reducing Regulator. The gauge at the right shows the delivery pressure; the small line in the foreground is the pilot line; the valves on both sides of the regulator are stop valves, while the by-pass and its single stop valve can be seen directly behind the main line.

This type is built for initial pressures up to 2500 pounds per square inch; for delivery pressures up to 1200 pounds per square inch; and for temperatures up to 1000 degrees Fahrenheit. In addition to this single-seated type, double seating is available in the Foster Type 39-Q2.

Are you interested in accurate, sensitive pressure regulation in a valve that is as simple to set as letting a few pounds of air in—or out—of an automobile tire?

Then you should investigate the new Foster Type 39-Q1 Pressure Reducing Regulator and its revolutionary design feature . . . the "dome that does it."

There are no springs, no weights in this simple regulator. A constant load on the valve is imposed by the air pressure in the dome . . . accuracy of regulation is unaffected by spring deflection and hystersis.

Adjustment? Simply change the dome load and you change the delivery pressure. A few strokes of a hand pump or a "shot" from a compressed gas bottle increases the delivery pressure . . . while opening the check valve in the dome decreases the delivery pressure.

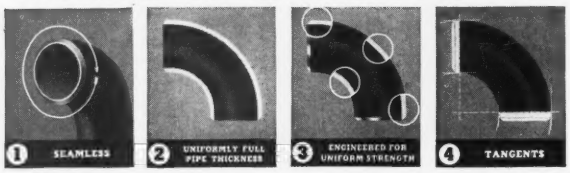
An eight page, fully illustrated bulletin containing complete information on this regulator is just off the press. A copy will be sent to you without cost or obligation . . . ask for Bulletin 10.

FOSTER ENGINEERING Company

PRESSURE REGULATORS • RELIEF AND BACK PRESSURE VALVES • AUTOMATIC STOP AND CHECK VALVES • ALTITUDE VALVES • DAMPER REGULATORS • FAN ENGINE REGULATORS PUMP GOVERNORS • TEMPERATURE REGULATORS • LIQUID LEVEL CONTROLLERS • FLOAT AND LEVER BALANCED VALVES • NON-RETURN AND TRIPLE DUTY VALVES • VACUUM REGULATORS OR BREAKERS • SIGHT FLOW BOXES • STRAINERS • SAFETY VALVES

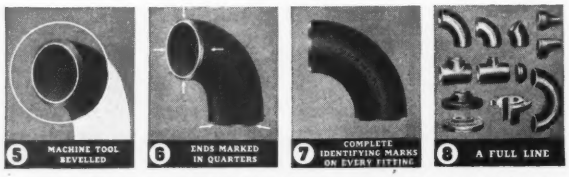
111 MONROE STREET • NEWARK, N. J.

TAYLOR FORGE



On your next job

make the acquaintance of the only welding fittings that offer you all these 8 aids to faster, easier welding.



WeldELLS

Seamless Pipe Fittings for Welding

TAYLOR FORGE & PIPE WORKS

General Offices and Works: Chicago, P. O. Box 485

New York Office: 50 Church St.

Philadelphia Office: Broad Street Station Bldg.

McClave Co., successor to McClave-Brooks Co. of Scranton, Pa., is to start making grates and stokers in a new plant on Mill St., Allentown, Pa., with present offices at 936 Hamilton St. Castings will be made by Kline Hardware Co., whose president, S. G. K. Stradley, will be secretary of the McClave Co. Other officers are Robert B. McClave, president; Keith R. Manville, treasurer. Products will cover the same range as those made for 58 yr. by McClave-Brooks Co.

Revere Copper & Brass, Inc., announces, through its president C. Donald Dallas, the establishment of a $10,000 fund to be used in paying prizes for the best suggestions to aid in speeding up the American industrial defense program submitted by workmen in the metal industries. This is done as a reply to William S. Knudsen's plea to "forget everything except the welfare of our country."

The plan is worked out as a result of a similar procedure in the Revere organization to bring out ideas from men who may hesitate to suggest ideas which may prove of great value. These may not be big or revolutionary and are likely to come from younger men and from experienced shop men as a result of observation in their daily work.

Details will soon be publicized by circulars and by notices on plant bulletin boards, the awards, which run from $5000 graduated to $250, being made by a jury, consisting of Harry Heald, president of Illinois Institute of Technology, chairman; Admiral Joseph Strauss, U. S. N., retired; Major General Frank Parker, U. S. A., retired; Robert Matt, former delegate to International Labor Conference at Geneva; C. Donald Dallas, president, Revere Copper and Brass Inc. All ideas are to remain the property of their originators.

Anticipating increased demand for neoprene, or synthetic rubber, E. I. du Pont de Nemours & Co. has started construction of a further addition to its neoprene plant at Deepwater Point, N. J. These new facilities, expected to be completed in October, 1941, will supplement a plant addition of the same size which has just been finished.

Together the two latest additions will increase in capacity by 1,000,000 lb. per mo., raising the total production facilities to 1,500,000 lb. per mo., six times the capacity available in the summer of 1939.

General Charles Keller, since 1923 associated with the Standard Gas & Elec. Co. system in various engineering and executive capacities, has been returned to active duty by order of the War Department as Brigadier General Engineer of the Chicago District with the rank of Brigadier General. He graduated from West Point as Number Two Man in the class of 1890, did graduate work at the academy, and served for a number of years as assistant in various engineering districts throughout the country.

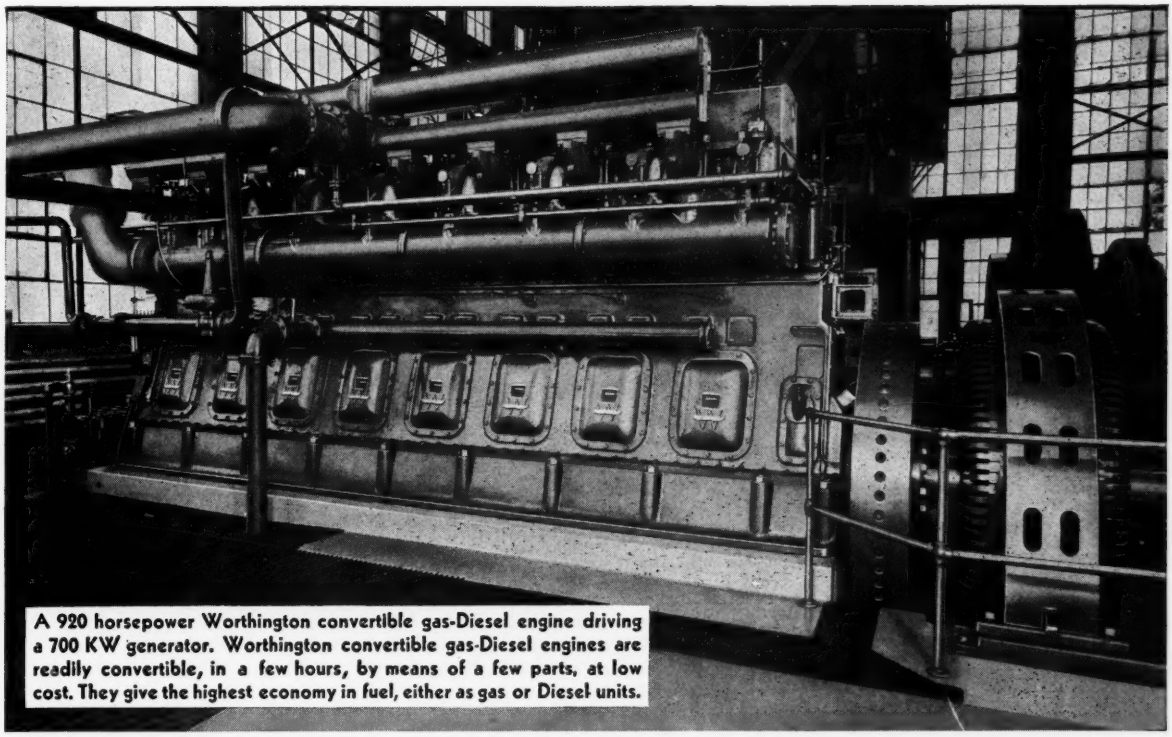
In 1916, he was ordered to Washington as assistant to the Chief of Engineers. At the outbreak of the war, he became the executive of the committee organized by the Director General of Railroads for the purpose of formulating utilization of waterways to supplement the railroads. He played a part in the establishment of a plan for the fixation of atmospheric nitrogen, and later organized the Power Section of the War Industries Board which was responsible for the efficient utilization of electric energy.

In 1918, he served as Deputy Chief Engineer of the American Expeditionary Forces in France, and after returning to this country, became resident engineer of the Board of Engineers for Rivers and Harbors and then engineer commisisoner of the District of Columbia. He resigned in 1923 to become affiliated with the Standard Gas & Elec. Co. System. In 1926, he represented the United States Government in the 14th National Convention of Navigation in Cairo, Egypt. His assignment to Chicago Engineer District went into effect on November 25, 1940.

The Thirty-Second Annual Meeting of the National District Heating Association will be held June 10th to 13th, 1941, at the William Penn Hotel, Pittsburgh, Pa.

National Oil Burner Exhibition and Convention will be held at Commercial Museum, Philadelphia, Pa., March 17-22, 1941. At present over 80 per cent of the space has been taken by 130 exhibitors. Tentative program of the convention will be prepared at a meeting of the executive committee Dec. 2nd but industrial mobilization for national defense will be given prominence, also applications in connection with air conditioning for homes.

Worthington Diesel and Gas Engines for Uninterrupted Power Service



A 920 horsepower Worthington convertible gas-Diesel engine driving a 700 KW generator. Worthington convertible gas-Diesel engines are readily convertible, in a few hours, by means of a few parts, at low cost. They give the highest economy in fuel, either as gas or Diesel units.

Continuity of service, now, more than ever before, is a production factor of prime importance

WORTHINGTON AUXILIARIES GIVE

added service security, through the undivided responsibility of one maker.

AIR COMPRESSORS FOR STARTING

CENTRIFUGAL PUMPS FOR JACKET WATER CIRCULATION

EVAPORATIVE COOLERS FOR JACKET WATER COOLING

ROTARY PUMPS FOR FUEL OIL TRANSFER

Such service is a matter of definite record in hundreds of Worthington engine installations, and in a wide variety of applications.

Further, in addition to continuity of service, operating economies will contribute substantially to future profits.

An expert WORTHINGTON engineering staff is ready to help you in the solution of your power problem, and to render a complete and qualified recommendation, without bias or obligation.

DIESEL ENGINES 60 to 1800 hp.

CONVERTIBLE GAS-DIESEL ENGINES 70 to 1500 hp.

GAS ENGINES 70 to 2160 hp.

FOR CONTINUOUS HEAVY DUTY

WORTHINGTON PUMP AND MACHINERY CORPORATION

General Offices: **HARRISON, NEW JERSEY**

DEO-9 *Branch Offices and Representatives in Principal Cities throughout the World*

WORTHINGTON

WHY PAY 800% MORE?

Every time you replace a worn bronze gate valve with a new one, you are paying about 800% *more* for that new valve than it would cost to repair a Fairbanks *Renewable* Bronze Gate Valve. For when the Fairbanks seat rings wear, they can be replaced for about 10% of the original cost of the valve . . . then the valve is as good as new.

Fairbanks Renewable Valves

also save time, labor and expense by enabling you to make renewals in a few minutes without removing valves from the line or disturbing pipe coverings.

Why not stop this deplorable waste now by replacing worn valves with Fairbanks "Renewables"? They're made in bronze and iron, in types and sizes to meet practically every requirement.

Write today for Catalog No. 21 and name of our nearest distributor.

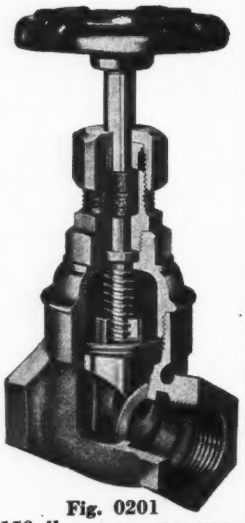


Fig. 0201
150 lbs. steam pressure

THE FAIRBANKS COMPANY

Valves, Dart Unions, Hand Trucks and Wheelbarrows

399 Lafayette St., New York, N.Y.

Boston, Mass., Pittsburgh, Pa.—Distributors in Principal Cities

Factories: Binghamton, N. Y., Rome, Ga.

In future Wm. B. Scaife & Sons Co. will be known as Scaife Co., to give a simpler name, but corporate structure, management and products will be unchanged. The business was founded in 1802 in Pittsburgh, Pa., moved to Oakmount, Pa., in 1892 and for five generations sons have succeeded fathers as head of the company. It is interesting to note that in the war of 1812 the company made sponge buckets for the artillery, and is now again doing its share in defense work. Present officers are. J. V. Scaife, Jr., President and Chairman of the Board; Alan M. Scaife, Vice President and Director.

Cooper-Bessemer Corp. has received from the city of Connersville, Indiana, an order for one of its Type JS diesel, 415 hp. engines, to be delivered on or about March first, as a third addition to the present municipal light and water plant. The new engine will drive a 300-kw. Westinghouse generator and 7.5-kw. exciter.

Garratt-Callahan Co. of Chicago, Ill., manufacturers of Magic Boiler Preservative, announce the transfer of W. L. Hays from St. Paul to the Memphis territory. Mr. Hays has been associated with the Garratt-Callahan Co. for over 25 yr. and his experience will add to the effectiveness of the company's sales force in the south.

T. F. Barton, for the past 2 yr. assistant district manager of the New York district of the General Electric Co. has been appointed district manager, effective January 1, according to an announcement by E. O. Shreve, vice president in charge of sales. Mr. Barton becomes administrative head of the apparatus sales organization for the states of New York, Connecticut, and northern New Jersey. H. H. Barnes, Jr., for many years commercial vice president of the New York district, will continue in that capacity.

Mr. Barton, a native of Orangeburg, South Carolina, was graduated from Clemson A. & M. College in 1906 with the degree of B. S. in E. E. and entering the testing department of the General Electric Co., was soon transferred to the direct current engineering department in 1909, then to construction engineering work for the New York district office.

From 1917 to 1927, he was member of the Central Station Engineering department at Schenectady, and became district engineer of the New York district in 1927 acting in that capacity until 1939. Mr. Barton has twice won Charles A. Coffin Foundation awards for outstanding contributions to the electrical industry. He is a fellow of the A.I.E.E. and a director and past vice president of the national organization.

Julian E. Tobey, vice president in charge of engineering for Appalachian Coals, Inc., Cincinnati, Ohio, has been appointed by Governor Bricker of Ohio to serve as a member of the State Board of Registration for Engineers and Surveyors. His term will end in September, 1945.

To meet defense program requirements, in its four plants at Canton, Gambrinus, Columbus and Mt. Vernon, Ohio, Timken Roller Bearing Co. is erecting buildings totaling 184,625 sq. ft. at a cost of $572,000. Orders for machine tools to cost $961,825 have been placed and for a 60-t. electric furnace to cost $551,000; also on file are orders for $132,175 for maintenance equipment.

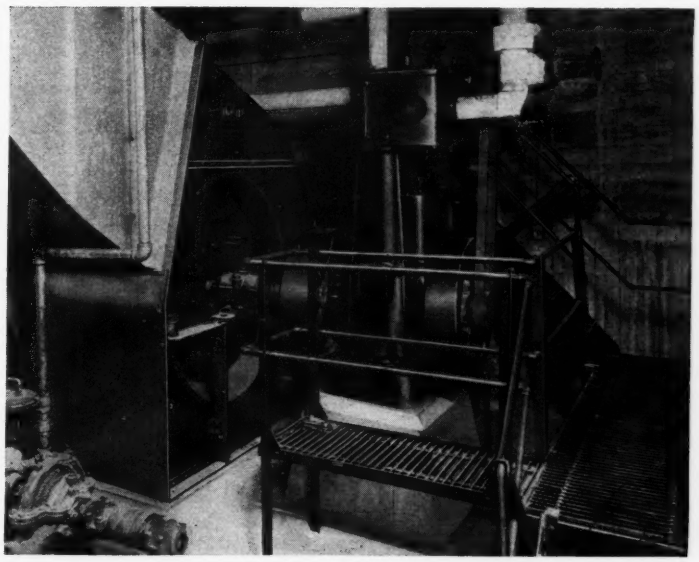
Promotion of R. J. Thompson, previously with Detroit office of Ampco Metal Inc., is announced, to be Eastern District manager with headquarters at 30 Church St., New York, and overseeing engineering offices in Boston and Springfield, Mass., Philadelphia, Pa., and Washington, D. C.

S. C. Lawson, will continue at his office 600 So. Michigan Ave., Chicago, Ill., but will take charge of the central district, including Chicago, St. Louis, Indianapolis, Cincinnati and Michigan territories.

Elgin Softener Corp., Elgin, Illinois, announces the recent appointment of Robert D. Murphy as District Representative in Western and Central New York with headquarters at 431 Brisbane Building, Buffalo, N. Y. Mr. Murphy, the son of R. J. Murphy who is in charge of Elgin's Cleveland office, has specialized in the field of water conditioning, softeners, filters, continuous blowdown, deconcentrators, oil removal, water testing.

A. C. Harvey Co., Allston, Mass., who have been identified for years with the sale of steel products and welding equipment in New England, have been appointed jobbers of the line of Hobart Multi-Range Arc Welders, to collaborate with Leo Gordon of the New England distributing office.

No. 7 in a Series of True Low Power Costs



Here's a Fan-Steam Engine Installation Similar to that in a Michigan School where ANNUAL SAVING OVER NEXT BEST DRIVE IS $961 INCLUDING ALL CHARGES

Because the installed cost of the steam engine was $1333, the savings will pay for the entire cost in 17 months—for the extra cost of the engine in 7 months—and give a yearly return of 170% on the extra investment. Steam engine power is 78% cheaper.

Because the modern steam engine is dependable and requires no particular repairs or maintenance for years, the $961 savings are going to help lower the cost of running that school for at least a generation.

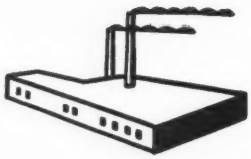
Our shops are busy, not especially because of defense contracts, but because there is a growing appreciation of what the Troy-Engberg Steam Engine can do in the way of lowering costs—costs of driving stokers, compressors, fans, blowers, cookers, generators, dryers, etc.

Why not look into its merits for your plant? First send for Bulletin 101 which shows how the Troy-Engberg Steam Engine is producing power for an average of ½ cent per kw.h.

TROY ENGINE & MACHINE CO.

Established 1870

835 RAILROAD AVE., TROY, PA.



4385 of Americas Leading Plants Now Furnish Their Employees

Formula SBS-II

Each day more and more power and manufacturing plants are specifying FORMULA SBS-11, the modern industrial skin cleanser because:

SBS-11 cleans safely, rapidly, thoroughly.

SBS-11 helps prevent skin irritation, dermatitis and infection.

SBS-11 leaves hands smooth, soft, chap-free.

SBS-11 costs less than 1¢ per worker per week.

Write today for generous FREE TRIAL SUPPLY to Sugar Beet Products Co., 400 Waller Street, Saginaw, Michigan. State number of employees.

Formula SBS-II

THE WASHWORD OF INDUSTRY

New Engineering Books

Sabotage—How to Guard Against It. By Harry Desmond Ferren. Published by the National Foremen's Institute, Inc., New York, N. Y. 60 pages. Price $1.00.

The author portrays the operations of saboteurs during World War I, and highlights the sabotage cases during World War II. Meticulously, the book reveals the machinations of the Nazi sabotage network, as directed by the Auslands Organization. Here is where you begin to see what happened to France, and why Winston Churchill rounded up all suspected subverters. Methods employed by the A. O., as revealed in this book, in propagandizing Germans abroad and bringing them to heel will tingle the hair on your neck. The author predicts axis saboteurs have already received total war orders against American Industries, and sets forth proof that the saboteur is here, what he will do, how he will do it, and what you can do about it.

This book, although intended for industrial workers, should be read by all Americans who have their country's good at heart.

Fundamentals of Welding Metallurgy. Published by The American Welding Society, 33 West 39th Street, New York, N. Y. Imitation black leather cover, 357 pages. Price $1.50.

Recognizing the need for a brief textbook on the ABC of metallurgy which would enable one to understand and appreciate the metallurgical problems involved in welding.

The book was written primarily to familiarize members of the welding industry with the composition and structures of the metals commonly used, to show the effect of varied conditions of heat and stress in welding, to explain heat treatment and to illustrate how the knowledge of metallurgy can be used to control the welding processes.

Safety Rules for Power Companies, a 24 pp. pamphlet distributed to policy holders of the Employees Mutual Liability Insurance Co. of Wausau, Wis., without obligation, while a price of 25 cents is charged to non-policy holders.

The first of three sections deal with qualifications of workers, inspection, reports of defects, tests of protective equipment, supervision of workers, grounding requirements and precautions when working on live wires. Sections 4 and 5 cover work in stations, maintenance, testing, repairs, and protection of employees. Safe practices when working on and around pole lines, safety equipment for line men and practical first aid is covered in sections 6 to 8.

The rules are intended as a concise summary for use by power companies that do not maintain an extensive safety organization and are judiciously selected and phrased and should result in helping to avoid accidents and increase caution.

Specifications for Pipe and Piping Materials. Published by the American Society For Testing Materials, 260 South Broad St., Philadelphia, Pa. Size 6 by 9 inches. 127 pp. Spiral bound cardboard cover. Price $1.25.

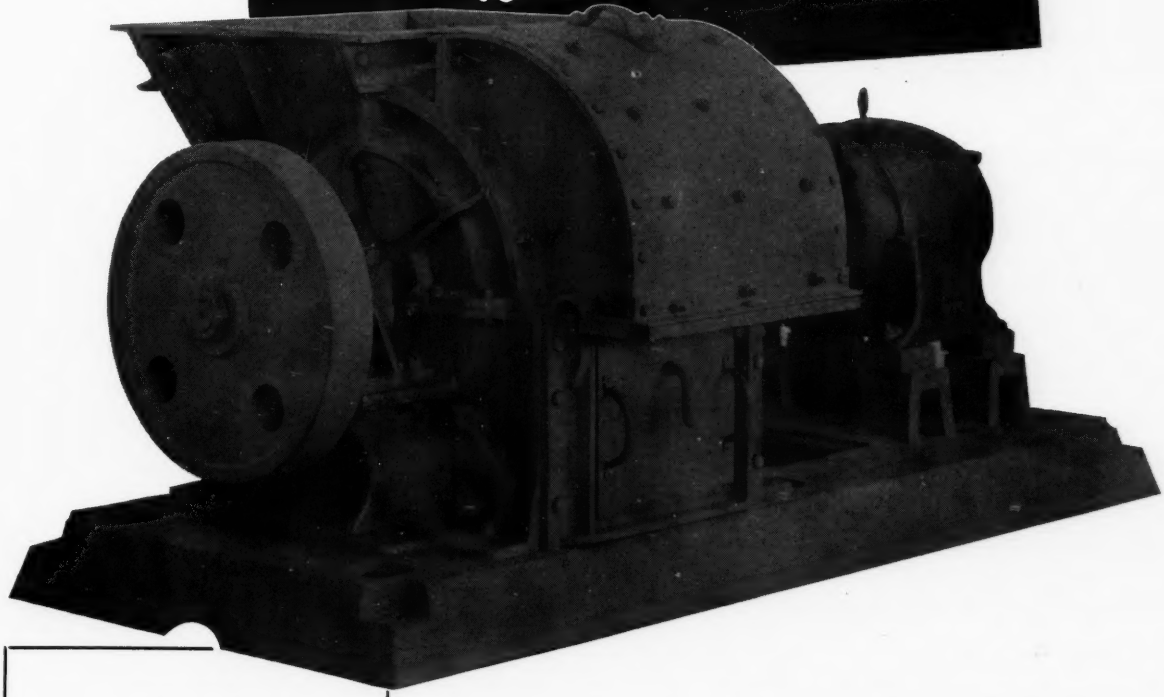
This is a selective compilation of twenty-four of the forty A.S.T.M. specifications covering pipe and piping materials, particularly those used in high-temperature and high-pressure services as used in power plants and industrial installations.

Eleven of the twenty-four specifications cover various types of carbon and alloy steel pipe and boiler tubes, including the specifications for classification and dimensions of wrought iron and wrought steel pipe. Four items cover carbon and alloy steel castings, three bolting materials including nuts, and four forgings and welding fittings. The classification of austenite grain size in steels with two grain size charts is also included.

Special prices are in effect for orders for ten or more copies.

Performance of Ammonia Condensers of the vertical open shell-and-tube as well as horizontal closed shell-and-tube types is covered in a new 8 pp. section (with three charts) of the Equipment Standards published by the Air Conditioning and Refrigerating Machinery Association, Incorporated, Southern Building, Washington, D. C. Copies can be obtained direct from the Association for 25 cents each.

Memo to men who want to trim fuel costs



IMPORTANT TYPE "S" FEATURES

This improved "AMERICAN" Ring Crusher pictured above is unbreakable from any crushing strain—anti-friction bearings—patented adjustable grinding plate—tramp metal passed without injury.

PATENTED SHREDDER RING SPLITS COAL

The improved Shredder Ring developed by "AMERICAN" designing engineers (see below) makes it possible to size coal properly for either stoker or pulverizer fuel firing by making a simple adjustment. Through the use of a reversible manganese Shredder Ring, coal is actually SPLIT rather than crushed.

American Ring Crushers can save up to 8%!

Scores of industrial plants, central stations and service institutions have started their boiler room economy programs with AMERICAN Ring Crushers.

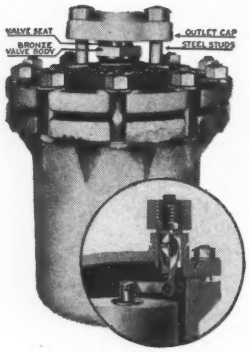
These plants report that the improved operating efficiency — due to better coal sizing with "AMERICANS"—have reduced total fuel costs from 2½ to 8%, on either pulverized or stoker coal burning.

You, too, can size coal for savings the "AMERICAN" way. Our engineers will gladly place you in touch with "AMERICAN" equipped plants where you will be given every opportunity to check the actual savings being effected.

AMERICAN PULVERIZER COMPANY
1429 Macklind Avenue
St. Louis, Missouri
ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

K-MASTER

INVERTED BUCKET STEAM TRAPS



Trap Inspection Made Easy

...and any trap should be inspected regularly

The most important part of a trap is the valve and valve assembly because trouble usually develops there if it develops at all.

Note how easy it is to get at this part of the K-Master Trap. Remove two nuts and take off the cap. That simple step releases the valve and assembly. Contrast this with traps which require the removal of many nuts. Even the fulcrum below the valve can be checked without further taking apart. Only if it is necessary to check the bottom of the trap must the cover be removed.

The K-Master traps steam as efficiently as any and more efficiently than most. But it surpasses any in its simplicity and ease of inspection.

A descriptive catalogue will give you the details.

T T T

Thousands of K-Master Traps are giving efficient service in hundreds of plants.

KAYE & MACDONALD, Inc.

92 Franklin Avenue West Orange, N. J.

Materials Handbook. By George S. Brady. Published by the McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York City. Size 6 by 9 in.; 540 pages; cloth bound. Price $5.00.

More than a handbook, this is in fact an encyclopedia for purchasing agents, engineers, executives and foremen and for more than 10 yr. has been a bible of industrial materials. Altogether it represents 20 yr. of work, the outgrowth of a card index system used by the author when he was American Trade Commissioner to three foreign countries. This, the fourth edition, has been brought up to date with current practice.

The book is arranged alphabetically by materials beginning with "abrasives" and ending with "zirconium-ferrosilicon." Data on each material ranges from a paragraph to two or three pages, including general information, the most commonly used comparative figures, with, in many cases, patented and trade name materials described to give a more specific understanding of commercial applications. The general utility of the book is increased by an appendix of 22 pp. covering such information as weights and measures, metal gages, hardness numbers, temperature conversion scale, material units, physical properties of metals, materials, the chemical elements, electrical conductivity, specific gravity, etc.

Sales Engineering. By Bernard Lester. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Size 5½ by 8½ in.; cloth bound; 200 pages. Price $2.00.

Inasmuch as the title of this book is very specific and leaves no doubt that its purpose is to tell how to sell equipment and services which require engineering skill in their selection, application and use, it is well to consider the purpose of the author in tackling such an involved subject and pioneering in a field where books are badly needed.

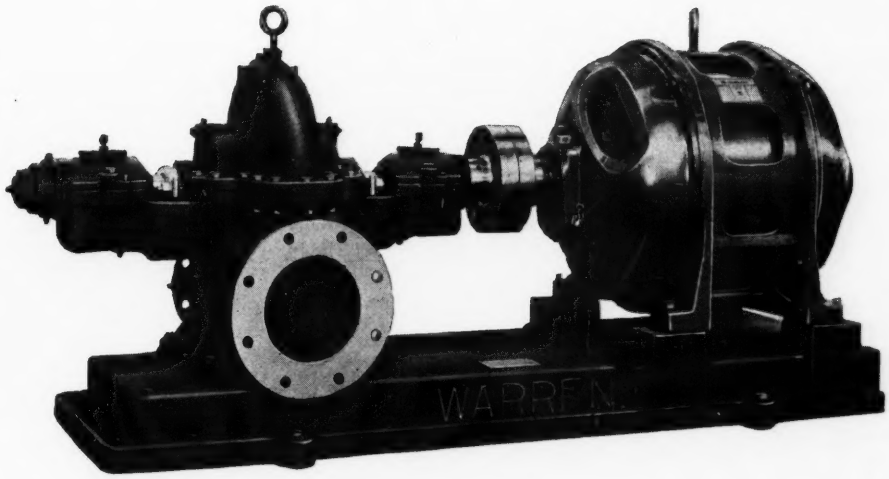
Each year a large number of technical graduates enter the field of sales engineering and questions such as: What is sales engineering? What possibilities does it offer? What must one do to be successful in this work? are becoming more frequent. The book is: an answer to these questions in simple terms without sales promotional adornment; to present the principles of sales engineering; indicate the importance of the work and its relation to present-day industrial organization. The secondary purpose is to help the experienced sales engineer improve his present methods and help technical engineers increase their usefulness through a better knowledge of sales engineering principles and practices.

The book is divided into three parts: I, The field of sales engineering; II, The work of the sales engineer in selling, and III, The training and development of a sales engineer. It is very well done, written in a convincing and interesting manner and its readability is improved by what might be considered case studies introduced as specific applications of the general principles set forth in the remainder of the text. The author is with Westinghouse Electric & Mfg. Co. and is also the author of Applied Economics for Engineers.

Steam Turbine Principles and Practice. By Terrell Croft, (Second Edition) revised by S. A. Tucker. Published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York City. Size 5 by 8 in., 292 pp., cloth bound. Price $3.00.

Terrell Croft's Power Plant Series is too well known to need detailed description. For many years they have been the standard of practical books covering the principles and applications of power plant equipment. The second edition revised by S. A. Tucker follows the same practical treatment as the original edition, but rewritten and revised in order to bring it up-to-date and to conform to changes in practice which have occurred in the 17 yr. since the first edition appeared.

It is intended to give the operating engineer, plant superintendent, and manager such information as is necessary to insure the successful, and economical operation of turbines or to make a wise choice in the purchase of a new turbine covering insulation, operation, lubrication, testing and maintenance, steam turbine economics, and details of present turbine types and auxiliaries.



THE PUMP
that put a Coal Bill to Shame

An eastern textile mill required a reliable supply of hot water for washers. Ample steam was available for water heating when the plant started up, but was inadequate as shop production increased. . . . A Warren engineer recommended a storage tank installation and a circulating loop with a Warren pump to circulate hot water through the plant.

When the installation was complete there was an unbelievable saving in coal, and in addition, a tremendous saving in chemicals. Moreover, the mill has since doubled production without additional power plant equipment except as outlined.

The same kind of engineering skill and experience that made this saving possible is available to you through your Warren representative. If you seek better pump performance at lower cost, you'll find it good business to consult Warren engineers.

WARREN PUMPS
Warren Steam Pump Co., Inc., Warren, Mass.

$6,000,000 for Huntley Addition

BUFFALO Niagara Electric Corp., Buffalo, N. Y., has authorized plans for a 6,000,000 addition to Charles R. Huntley station, to increase the capacity by 80,000-kw., making a total rating of 545,000-kw. for the plant. Award has been given to General Electric Co. for the steam turbine-generator unit, to be the first large condensing unit of this kind, it is stated, to be built in a single casing and using steam at a pressure of 1250 lbs. per sq. in. The generator will be hydrogen-cooled. Installation will include new high-pressure boilers, auxiliaries, expansion in switchyard and other work. Awards for various equipment required will be made in near future. About 24 months will be reqired for completion of project.

Kentucky Utilities Propose $3,000,000 Plant

KENTUCKY Utilities Co., Louisville and Lexington, Ky., has plans maturing for new steam-electric generating station on the Kentucky River, near Tyrone, Ky., where a tract of about 275 acres of land has been acquired at a place known as High Bridge. The plant will be equipped for an initial capacity of 25,000-kw. A large switchyard will be built for connection with company transmission system in the eastern part of the state, including interconnection with steam stations at Lexington and other points, and hydro-electric plants on the Kentucky River; line connection also will be made with company system at Louisville and vicinity. It is expected to place awards for equipment at early date. Entire project is estimated to cost close to $3,000,000, and will require about 24 mo. for completion.

Power for New York Transit Lines

BOARD of Transportation, New York, N. Y., is considering the development of power supply for the municipal transit system, including extensions and improvements in two power plants acquired by the city in its transit unification program. These are located at Fifty-ninth street and Hudson River, and at Seventy-fourth Street and East River, and formerly were privately operated. Surveys and reports have been made by the J. G. White Engineering Corporation, 80 Broad Street, New York, under authorization of the Board of Estimate, and presents two programs for consideration, one representing an expenditure of $10,866,000 over a 3 to 5 yr. period, and the other to cost about $50,000,000 over a term of 11 years.

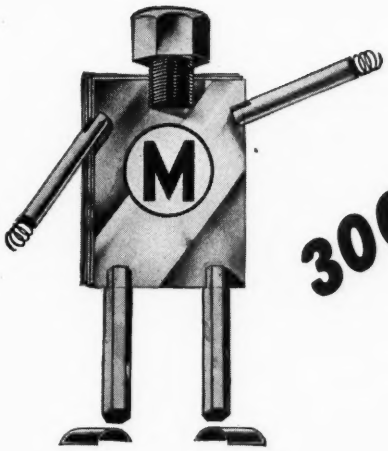
The first program provides for the modernization and improvement of the two power stations and existing equipment, with the installation of new turbine-generators, high-pressure boilers and auxiliary apparatus. It is estimated in the engineering report that this procedure would result in a saving of approximately $1,500,000. The larger project noted, would include similar modernization of stations, but with installation of new equipment in excess of the capacity provided under the first noted plan; further, this would provide for the installation of new cable lines, substation apparatus and other facilities to bring about an estimated saving to the city of about $4,500,000 annually. At the present time, the municipality purchases power from the Consolidated Edison Co., for the operation of what is known as the Independent Subway System, while the Interborough Rapid Transit and Brooklyn-Manhattan Transit lines are furnished with power requirements from municipal plants.

Plans $8,000,000 Expenditure

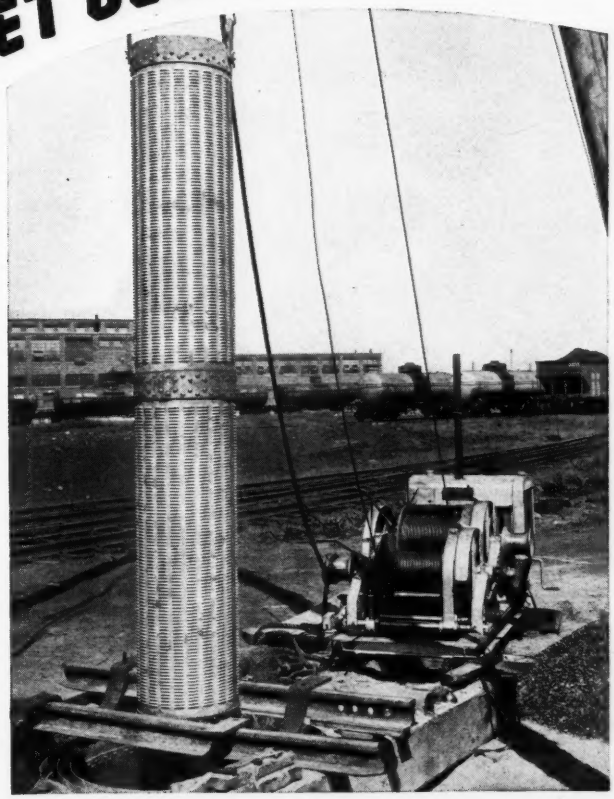
THE COMMONWEALTH & Southern Corporation, New York, N. Y., has tentative plans under consideration for an expenditure of about $8,000,000 for expansion and improvements in generating stations of different systems. It is estimated that this will provide an increase of about 110,000-kw. capacity in the various plants, of which about 70,000-kw. will be for Northern properties and 40,000-kw. in Southern stations. Detail of location and other features of the program are now being determined.

Projects will be carried out as a feature of 1941 construction developments, with the majority of the increased power to be available in 1942. This will be part of the 1941 budget of the company for its various properties. The 1940 expenditures will approximate close to $38,000,000 and it is expected that the 1941 budget will at least equal, if not exceed that amount. The company now has work in progress at its different stations for an increase of 260,000-kw. generating capacity, all scheduled for completion next year.

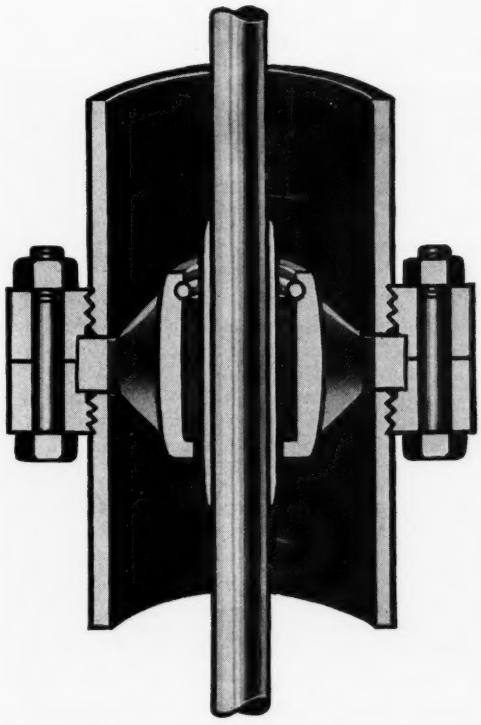
Even Your Pressure Reduction Controls can be
CENTRALIZED-for better Supervision and Safety-
with SWARTWOUT MASTER EQUIPMENT
YOU APPRECIATE time saved in the exacting job of power supervision—can always use it profitably. Swartwout Master Equipment gives you the same flexibility of location for pressure reduction controls as with most of your instruments. . . You avoid scattered supervision and the danger of overlooked adjustments on out-of-the-way valves—prevent costly delays or accidents • As illustrated, six Swartwout CPM Master Controls are grouped in conjunction with recording instruments at the Pan American Refinery, Texas City, Texas—a compact, time-saving control station. You can enjoy the same or a similar admirable set-up, as thousands of Swartwout users do. Take advantage of Swartwout's 36 years experience—write for Bulletin S-22-B today, or describe your problem.
THE SWARTWOUT CO • 18541 EUCLID AVE. CLEVELAND, OHIO
Feed Water Regulators • Pump Governors • Feed Water Heaters
Master Controls • Reducing Valves • Separators • Exhaust Heads
Swartwout
•Power Plant Equipment•



"I GOT A JOB 3000 FEET BELOW DALLAS!"



Monel's latest job in Dallas is no surprise, when you learn what happened at Amory, Mississippi. The well that supplied the town was shut down after eleven years on account of corrosion. Inspection showed that the steel casing had failed. It had to be replaced...but the Monel screen was so good that after cleaning it was put back to work. So Dallas is taking no chances with its 2,225,000 gallons a day water supply. Dallas is using 65 feet of Monel screen similar to that shown at the right.



In deep well installations, Layne and Bowler, Inc. of Memphis, Tenn., makers of the pumping equipment, find another big problem is that of rust proof shaft sleeves. The photo at left shows how they solve it. Monel wearing sleeves are heated to 850° F. and shrunk on the shaft at 10 foot intervals for contact with the water lubricated cutless rubber bearings. Not only do these sleeves resist corrosion but also sand abrasion, which is severe. Incidentally, the "spiders," which hold the rubber bearings, are made of "Ni-Resist" Nickel cast iron, and the shaft itself is Nickel alloy steel.

• • •

You, too, may secure the many advantages of Monel's corrosion resistance and long life wearing properties in deep well pumps by specifying Monel for vital parts such as drive shaft sleeves, gravel screens, impeller shafts.

Discuss these details especially with the pump manufacturer, and write to Inco for pamphlet "A Corrosion Problem 3000 Feet Deep." Address:

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall St., New York, N.Y.

INCO MONEL **MONEL**

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

MANUFACTURERS' NEWS

(Continued from Page 120)

B. H. Chamberlin

B. H. CHAMBERLIN, formerly of the Cutler-Hammer Detroit office is now with the company's Los Angeles sales

staff, according to a recent announcement by W. G. Tapping, manager of the Los Angeles District territory.

Mr. Chamberlin attended the University of Michigan and, joining Cutler-Hammer in 1935, he became a specialist in the construction and application of Multi-Breakers, Safety Switches, Motor Control and other C-H items.

Manning, Maxwell & Moore, Inc., of Bridgeport, Conn., announces that with the increased demand for its aircraft instruments, Joseph W. Yowell, for the past 5 yr. with the Pan-American Airways, in part at the Pacific Division, Alameda, California, in part at the Atlantic Division, LaGuardia Field, has joined the Instrument Division to handle Airplane Instrument sales. Mr. Yowell's duties will be to co-ordinate specifying and purchasing of Manning, Maxwell & Moore Airplane Instruments by the several foreign Governments having purchasing commissions in the United States.

W. C. Buchanan, president of Globe Steel Tubes Co., Milwaukee, Wis., was elected a member of the board of directors of Allis-Chalmers Mfg. Co. at the latter company's recent board meeting in New York. Mr. Buchanan was named to fill one of two vacancies on the Allis-Chalmers board created by the deaths of Gen. Otto H. Falk, former board chairman, and of Oscar Gubelman, a director for many years.

Born at Johnstown, Pa., in 1888, Mr. Buchanan studied mechanical engineering and metallurgy at a division of Carnegie Tech set up by the United States Steel Corp. He worked first for the Cambria Steel Co., Johnstown, in 1904 and by 1912 had charge of some of the firm's rolling mills and finishing departments. Then followed important jobs with American Tube & Stamp, Bethlehem Steel, where he helped rebuild the rolling mills of the Steelton plant, and Trumble Steel, Warren, Ohio. After that he went into financing in Cleveland and had a hand in consolidating various steel firms including Continental, Empire and others. In the early part of 1929 he became connected with Keystone Steel & Wire Co. and was president and general manager of that Peoria (Ill.) concern before resigning to take the presidency of Globe Steel Tubes, in Milwaukee. With his wide experience in plant management, Mr. Buchanan will bring to the Allis-Chalmers board a first hand knowledge of manufacturing problems.

Caterpillar Tractor Co. announces that Donald A. Robison has been made vice-president with administrative direction of all selling and advertising activities, the office of general sales manager, which Mr. Robison leaves being filled by the advancement of Gail E. Spain.

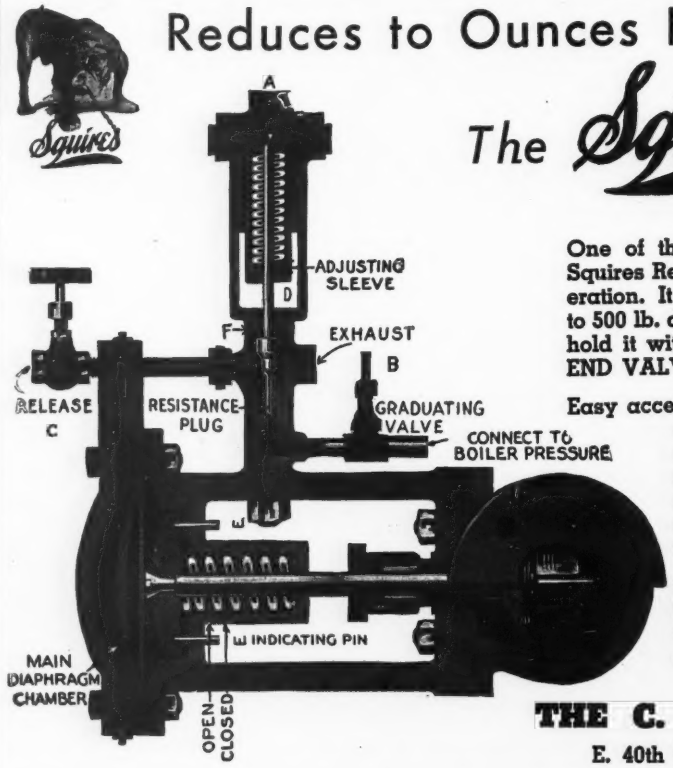
Arthur C. Nodine, former Philco Sales Manager for Refrigerators and Air Conditioners in the North Eastern States, has been appointed National Supervisor of Philco-York Air Conditioning, according to an announcement made by Harry Boyd Brown, Philco Manager of Air Conditioning Division.

Mr. Nodine has been with the Philco Corporation for the past 14 years. Prior to that he was employed by the Electric Vacuum Cleaner Company, of Cleveland, Ohio, as Advertising Manager.

The Babcock & Wilcox Tube Co., Beaver Falls, Pa., announces that the sale and distribution of its seamless steel tubular products in Argentina,

Reduces to Ounces In A SINGLE STEP

The Squires Reducing Valve



One of the big features engineers like about the Squires Reducing Valve is its simple, unfaltering operation. It will reduce any initial boiler pressure up to 500 lb. down to ounces in a single operation—and hold it without a quiver. IT IS A POSITIVE DEAD END VALVE.

Easy accessibility of working parts also helps guarantee the continuous accurate performance of the Squires Reducing Valve. The main valve is operated by initial pressure. As low as 25 lb. closes the valve so there is always a reserve to insure against any chance of non-closing.

Consult our engineers, without cost or obligation, about the use of this valve in your plant. Write for Catalog E-10½ describing the complete Squires line.

THE C. E. SQUIRES COMPANY

E. 40th St. and Kelley Ave., Cleveland, O.

Brazil, Paraguay, and Uruguay are handled by Babcock & Wilcox, Ltd., of London, England, through their offices in these countries.

A new office building of Ampco Metal, Inc., Milwaukee, has been made necessary by the demands of the production department for increased space in which to place new precision machine tools, for finishing castings. The company specializes in high strength, wear-resistant bronzes and alloys for special or severe service uses.

This new, two-story office, 45 by 100 ft., is constructed with glass block walls, to daylight the floor area, with modern fluorescent lighting, air-conditioning, and matched steel furniture. The first floor will be occupied by the office staff, while the second floor is for engineering, estimating, and drafting. The basement will be used as a meeting place for employees, engineering societies, and similar groups.

Midwest Stoker Association has announced that its permanent stoker and automatic coal heat exhibit at the permanent stoker and automatic coal heat exhibit at the Merchandise Mart in Chicago is now open for the specific purpose of displaying the latest and most modern automatic coal burning equipment to home owners and builders. The display will be officially known as the Automatic Coal Heat Room and provides a practical idea of the things with which the potential buyer or builder should be familiar.

Allis-Chalmers Mfg. Co. has announced the appointment of R. N. Miers as Eastern District Engineer of the company's Steam Turbine Division. For the past 6 yr. Mr. Miers has been traveling out of Milwaukee on steam turbine sales and general engineering matters. His new headquarters will be at the Company's Boston office.

Carnegie-Illinois Steel Corp. recently announced the appointment of E. A. Brown, Jr., as superintendent of the power and fuel division at its Gary works and F. L. Collins as assistant superintendent of this division.

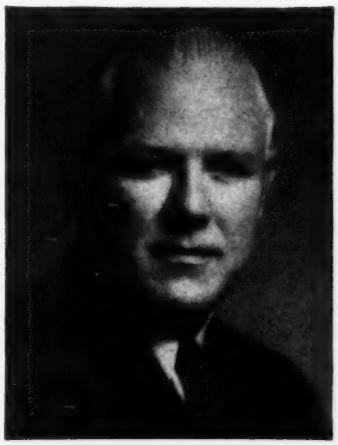
Mr. Brown, who has been in the industrial engineering field for the past thirty years, was superintendent of the fuel division at the time of his appointment. Mr. Collins was superintendent of power production in the maintenance division and has been associated with the Gary plant since 1909.

Eshelman and Potter, Charlotte, N. C., are pleased to announce the addition of David C. Miller, Hall Laboratories engineer, to their service staff. Well grounded in the theory and practice of boiler water conditioning, as recommended by Hall Laboratories, Pittsburgh, Pa., Mr. Miller will represent Eshelman and Potter interests in water conditioning service work among southeastern industrial plants.

Whiting Corporation, Harvey, Ill., announces the appointment of Shirley, Olcott & Nichols as its Washington sales representatives to look after Government work, with offices at 202 Mills Building, Washington, D. C.

A. D. Sutherland

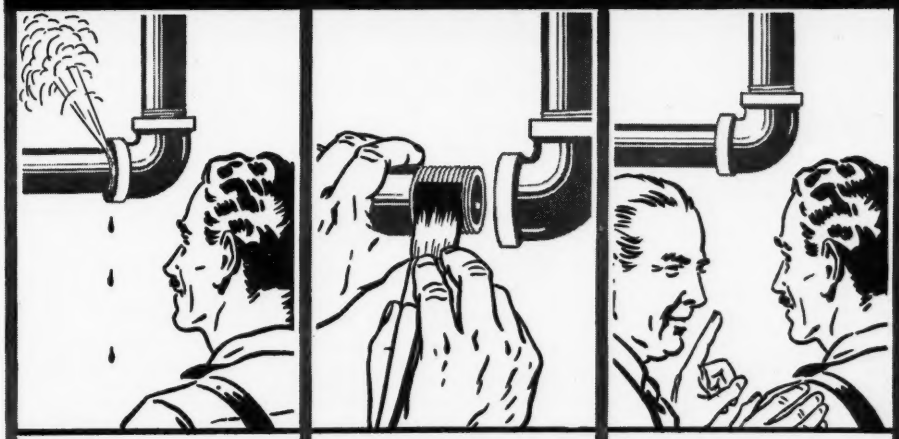
CHAPLIN-FULTON MFG. Co. has engaged as sales engineer A. D. Sutherland, for some years connected with the company of Lee C. Moore as sales manager for its eastern territory. Starting as a



tool dresser in Oklahoma, Mr. Sutherland participated in the gas boom of the Cleveland field in Ohio and later in the McKeesport, Pa., field, and has had experience since 1910 with equipment for the oil and gas industries.

Smooth-On Savings

Stopping a troublesome pipe-joint leak with SMOOTH-ON No. 3



A bad steam leak at a threaded elbow joint. Will it require a new elbow or a new length of pipe?

Not at all. Even if the threads are worn or damaged, Smooth-On No. 3 will make a tight seal.

Here is the joint—permanently leak-proof, for Smooth-On does not shrink, blow out or dry out.

FREE

The 40-page Smooth-On Handbook, with 170 diagrams showing practical repairs to equipment and pipe lines. Based on the experiences of thousands of engineers, and has many ingenious suggestions not published elsewhere.

Send the Coupon

Smooth-On No. 3 is equally applicable for making flanged and other thin joints tight, and for sealing rivets, seams, and bolts. It withstands high temperatures and pressures, and is impervious to water, gas, steam, air and many chemicals. Buy Smooth-On No. 3 in 1-lb., 5-lb. cans or 25-lb. kegs from your dealer or, if necessary, from us. For your protection, insist on Smooth-On, used by engineers since 1895.

Do it with SMOOTH-ON

Smooth-On Mfg. Co., Dept. 31,
570 Communipaw Ave., Jersey City, N. J.
Please send Smooth-On Handbook.

Name .....

Address .....

.....1-41

Power Plant Construction News

Calif., Sacramento—State Board of Education, Sacramento, plans power plant at California Maritime Academy, now located on San Francisco Bay, Marin County, to be removed to a group of new buildings at another location, soon to be determined. Power station will cost about $40,000, with boiler units and auxiliary equipment. A fund of $1 200,000 is being requested from state for entire project.

Calif., San Diego—San Diego Consolidated Gas & Electric Co., has approved plans for addition to power plant, for expansion in boiler house and steam division. Cost reported over $150,000, with equipment. Work will be placed under way soon.

Conn., South Meriden—Chandler-Evans Co., Evansville Avenue, manufacturer of aircraft parts, plans installation of electric power equipment in three one-story additions for large increased capacity. Entire project is reported to cost about $1,000,000. Austin Co., 16112 Euclid Avenue, Cleveland, Ohio, is engineer.

Ill., Rockford—Woodward Governor Co., 216-18 Mill Street, manufacturer of governors for hydraulic turbines and kindred apparatus, plans installation of electric power equipment in one-story addition to plant, 90x390 ft., and 220x226 ft., with center two-story section, 80x80 ft. Cost estimated over $200,000. Harza Engineering Co., 208 West Wacker Drive, Chicago, Ill., is consulting engineer.

Ill., St. Elmo—Council is considering installation of a new municipal power plant. Proposed to use Diesel engine-generator units and auxiliaries. Surveys and estimates of cost will be made by Engineering Service Corporation, Decatur, Ill.

Iowa, Hawarden—City Council plans early expansion and improvements in municipal power plant, including installation of new 1000-kw. turbine-generator unit and auxiliary equipment. Cost estimated about $92,000. Buell & Winter Engineering Co., Insurance Exchange Building, Sioux City, Iowa, is consulting engineer.

Iowa, Paullina—City Council plans extensions and improvements in municipal power plant, including installation of additional equipment for increased capacity. Buell & Winter Engineering Co., Insurance Exchange Building, Sioux City, Iowa, consulting engineer, has been engaged to make surveys and estimates of cost.

Md., Amcelle—Celanese Corporation of America, Inc., 180 Madison Avenue, New York, N. Y., manufacturer of rayon products, plans installation of electric power equipment in new two-story and basement addition to mill at Amcelle, near Cumberland. Work is scheduled to begin soon. Cost estimated close to $275,000.

Md., Baltimore—Rheem Mfg. Co., 30 Rockefeller Plaza, New York, N. Y., manufacturer of steel barrels, drums, etc., plans installation of electric power equipment in new addition to branch plant at Sparrows Point, Baltimore, forming a one-story extension of about 100 000 sq. ft. of floor space to recently completed works at that place. Erection is scheduled to begin soon. Entire project will cost close to $300,000.

Md., Cheltenham—Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids (no closing date stated) for Diesel engine-driven alternator, air-starting equipment, fuel oil purifier, cooling tower, switchgear and auxiliary equipment for naval radio station at Cheltenham (Specifications 10079).

Mass., Boston—Coca-Cola Bottling Co., 30 Washington Street, Brighton, Boston, plans installation of electric power equipment in new one and two-story beverage bottling plant, 280x300 ft., on Soldiers Field Road. Entire

HENSZEY
BOILER FEED
REGULATORS

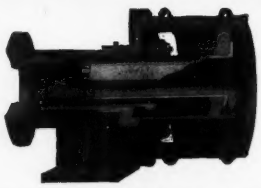
The Henszey Boiler Feed Regulator controls boiler water levels continuously and accurately under *all* load conditions! These simple, compact, self-contained units go right in the feed line and require no additional structural support. They are as easy to install as a simple gate or globe valve. Once installed and set for operation no further attention is necessary—nothing to get out of order—nothing to reset.

Send for latest Bulletin containing full details.

HENSZEY COMPANY Dept. C1—Watertown, Wis.

HENSZEY

ADSCO INTERNALLY-EXTERNALLY GUIDED JOINT



APPROVED by the ARMY and NAVY for NATIONAL DEFENSE PROJECTS

The ADSCO Internally-Externally Guided Expansion Joint meets the specifications of the Army Quartermaster Corps and the Navy Department Specification No. 66Pla. It has been approved for many years for installation on Army and Navy projects where the expansion and contraction of steam or hot water lines must be controlled with dependable equipment.

We are prepared to serve the national defense construction projects as they develop and the same dependable joints are available to private industry, colleges, institutions, public utility companies, etc., where they want time-tested steam distribution equipment that reflects over sixty years experience in its design and manufacture.

Write for Bulletin No. 35-20E

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.
IN BUSINESS OVER SIXTY YEARS

project estimated to cost about $275,000. Jesse M. Shelton, Bona Allen Building, Atlanta, Ga., is architect.

Mich., Dearborn—Ford Motor Co., Dearborn, plans installation of electric power equipment in new addition to cold rolled steel mill, forming an eight-bay extension. Entire project is reported to cost over $650,000. Giffels & Vallet, Inc., Marquette Building, Detroit, Mich., is architect and engineer.

Minn., Cass Lake—Village Council has plans under way for new municipal electric power plant and has called a special election on Jan. 7 to approve project. Surveys and estimates of cost have been made by G. M. Orr & Co., Baker Arcade Building, Minneapolis, Minn., consulting engineers.

Neb., Lincoln—State Board of Control, Capitol Building, plans addition to power plant at University of Nebraska, Lincoln, including installation of equipment for increased capacity. Cost estimated about $100,000. D. P. Daxon at Lincoln State Hospital, is state architect, in charge.

N. J., Elizabeth — Elizabethtown Consolidated Gas Co., 16 West Jersey Street, has plans maturing for new gas-generating station. Work is scheduled to begin soon. Cost reported over $100,000, including equipment.

N. J., Harrison—National Oil Products Co., Essex Street, manufacturer of special refined oil products, plans installation of electric power equipment in new addition to local plant, to cost about $350,000. Also in new additions to branch plant at Cedartown, Ga., to cost approximately $150,000; and in new plant to be located at Emeryville, Calif., or vicinity, for Pacific Coast service, to cost close to $150,000. Financing for entire project is being arranged.

N. C., Greensboro — Burlington Mills, Inc., Greensboro, plans installation of electric power equipment in new additions to silk and rayon mills at Greensboro, Burlington, High Point, N. C., and other points, entire project to cost over $1,500,000. Company is arranging financing through the sale of preferred stock to total amount of about $3,000,000.

Ohio, Toronto—Ohio Edison Co., Youngstown, Ohio, plans expansion in power plant at Toronto, including installation of new 35,000-kw. generator unit and auxiliary equipment. Work will be placed under way early in 1941, with work scheduled for completion in 1942. Project also will include extensions in transmission lines, and is reported to cost over $2,500,000.

S. D., Elk Point—City Council plans expansion and improvements in municipal power plant, including installation of heavy-duty Diesel engine-generator unit and accessory equipment. Also will make extensions in electric distribution lines. M. J. Robertson is mayor, in charge.

Texas, Dallas—Procter & Gamble Co., 1226 Loomis Street, manufacturer of soaps, edible oils, cleansers, etc., plans addition to boiler house at local plant. Cost reported over $85,000, with boiler units and auxiliary equipment. Work is scheduled to begin at early date.

Texas, Jasper—City Council has rejected bids recently received for new municipal electric power plant, including equipment. It is proposed to ask bids on revised plans in near future. No estimate of cost announced. H. B. Gieb & Co., Texas Bank Building, are consulting engineers.

Texas, Sonora — City Council, George E. Smith, city manager, plans new municipal electric power plant. Proposed to use Diesel engine-generator units and accessories. Surveys and estimates of cost will be made by Albert C. Moore & Co., Smith-Young Tower Building, San Antonio, Texas, consulting engineers.

Utah, Hatch—Garkane Power Association, Hatch, Robert A. Middleton, superintendent, plans addition to power plant, with installation of equipment for increased capacity. Station is used for service for rural electric system. Financing has been arranged through Federal aid.

Wash., Seattle—Boeing Aircraft Co., 7901 East Marginal Way, has filed plans for one-story addition to steam power house, 36x38 ft., and will proceed with erection at once. New boiler unit and auxiliary equipment will be installed. Cost reported over $50,000, with equipment.

W. Va., Alloy—West Virginia Hydroelectric Co., has approved plans for addition to hydroelectric generating station, with installation of equipment for increased capacity. Bids have been asked for structural steel framing for building and work will be placed under way soon. Cost estimated over $300,000, with equipment.

The WEDGE CHILL RING SPLIT FEATURE Assures PERFECT FIT!

Make 3 SAVINGS

1 SAVE LABOR
2 SAVE MATERIAL
3 SAVE TIME

Split Feature Patented

The WEDGE Chill Ring is not just "another" ring. It has the patented SPLIT Feature that greatly increases its efficiency because with this feature you are assured a PERFECT FIT. The SPLIT Feature is the reason WEDGE Chill Rings work satisfactorily where others failed. They are made of welding material to assure a perfect bond. WEDGE Chill Rings will give you a perfect job and eliminate the possibility of welding failures, and at the same time SAVE YOU MONEY. It will pay to investigate.

Write for Circular and Prices

WEDGE PROTECTORS, INC.

9526 Richmond Ave. Cleveland, Ohio

WEDGE CHILL RINGS SAVE MONEY

A "Pain-in-the-neck"

The engineer of a large industrial plant said, regarding the

CAMPBELL Feed Water Regulator

"It maintains the water level so perfectly that I frequently get a pain in the neck waiting for the level to change."

The CAMPBELL *is* a truly remarkable regulator, possessing many advantages such as:

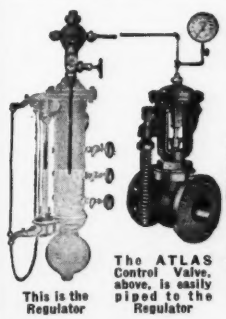
1—Continuous Blowdown;
2—No Moving Parts;
3—No Thermostats;
4—No Floats;
5—No Links;
6—No Generators;
7—Instantaneous Response;
8—Utmost Simplicity;
9—Lifelong Dependability;
10—High Efficiency;
11—Maximum Economy.

Its quick response to water level changes makes it ideal for handling abrupt load changes.

Also, where desired, the water level can be varied through a range of 5" or 6" before fully opening or closing the feed water control valve. In other words the CAMPBELL can be made to handle your own boiler conditions.

Ask for "17 Reasons why the CAMPBELL is Preferred by Boiler Operating Engineers."

We make regulating valves for every service. See partial list below. Check and mail with your name, firm name, and address.



This is the Regulator

The ATLAS Control Valve, above, is easily piped to the Regulator

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE
291 South St., Newark, N. J.

Representatives in Principal Cities

☐ Please send complete information on the Campbell Boiler Feed Water Regulator. Also, please send information on the following Atlas products.

☐ Damper Regulators
☐ Temperature Regulators
☐ Reducing Valves
☐ Exhaust Control System
☐ Pressure Regulators
☐ Pump Governors
☐ Float Valves
☐ Oil Control Cocks
☐ Humidity Controllers
☐ Thermostats
☐ Balanced Valves
☐ Control Valves

Where to Buy DIRECTORY

AIR CLEANERS
Johnson Corp., The

AIR COMPRESSORS
De Laval Steam Turbine Co.
Worthington Pump & Machy. Corp.

AIR PREHEATERS
Babcock & Wilcox Company, The
Combustion Engrg. Co., Inc.
Foster Wheeler Corporation
Green Fuel Economizer Co.

AIR WASHERS
American Blower Corp.
Badger & Sons Co., E. B.

ANTI-FRICTION METAL
Magnolia Metal Co.

ARCHES, BOILER & COMBUSTION
Carborundum Co., The
Detrick Co., M. H.

BAFFLES, BOILER
Engineer Co., The

BEARINGS, ANTI-FRICTION BALL AND ROLLER
Link-Belt Company

BEARING METAL
Magnolia Metal Co.

BELTING, SILENT CHAIN
Morse Chain Co.

BLOWERS, FAN AND FURNACE
American Coal Burner Co.
De Laval Steam Turbine Co.

BLOWERS, FORCED DRAFT, PORTABLE PRESSURE AND COAL
Green Fuel Economizer Co.

BLOWERS, TURBINE
Elliott Company
Terry Steam Turbine Co., The

BOILER BLOW-DOWN SYSTEMS
Centrifix Corp.
Cochrane Corporation
Elgin Softener Corporation
Henszey Company
National Aluminate Corp.

BOILER COMPOUNDS
Buromin Co., The
Dearborn Chemical Company
Garratt-Callahan Co.
Haering & Co., Inc., D. W.
Sugar Beet Products Co.

BOILER FEED WATER PURIFYING APPARATUS
Elgin Softener Corporation
Permutit Co., The

BOILER SETTINGS
Carborundum Co., The
Detrick Co., M. H.
Engineer Co., The

BOILER SETTING CEMENT
Carborundum Co., The

BOILER TUBES
Babcock & Wilcox Tube Co., Inc.

BOILER WALL COATING
Huyette Co., Inc., The Paul B.

BOILER WATER LEVEL CONTROL
Johnson Corp., The

BOILER WATER TREATMENT
Buromin Company, The
Dearborn Chemical Company
Elgin Softener Corporation
Garratt-Callahan Co.
Hall Laboratories, Inc.
Haering & Co., Inc., D. W.
Miller Mfg. Co.
National Aluminate Corp.
Permutit Co., The

BOILERS, POWER AND HEATING
Babcock & Wilcox Company, The
Cleaver-Brooks Co.
Combustion Engrg. Co., Inc.
Foster Wheeler Corporation
Keeler Co., E.
Murray Iron Works Co.
Springfield Boiler Company
Vogt Machine Co., Inc., Henry
Wickes Boiler Co., The

BOOKS
Audel & Co., Theo.

BRONZE BAR STOCK
Magnolia Metal Co.

CABLEWAYS
Sauerman Bros., Inc.

CEMENT, IRON
Smooth-On Mfg. Company

CEMENT, REFRACTORY, ACID PROOF, FURNACE AND HIGH TEMPERATURE
Babcock & Wilcox Company, The
Carborundum Co., The
Kellogg Co., The M. W.

CHAINS, CONVEYOR, ELEVATOR AND DRIVE
Link-Belt Company

CHAINS, DRIVE
Morse Chain Co.

CHAIN WHEELS
Babbitt Steam Specialty Co.

CHEMICALS, WATER TREATING
Betz, W. H. & L. D.
Buromin Company, The
Calgon, Inc.
Dearborn Chemical Company
Elgin Softener Corporation
Garratt-Callahan, Inc.
Haering & Co., Inc., D. W.
National Aluminate Corp.
Permutit Co., The
Sugar Beet Products Co.

CHIMNEYS
American Chimney Corp.

CLEANING COMPOUNDS
Calgon, Inc.
Dearborn Chemical Company

COAL, ASH HANDLING AND STORAGE EQUIPMENT
Fairbanks, Morse & Co.
Sauerman Bros., Inc.
Syntron Company

COAL CRUSHERS
American Pulverizer Co.
Link-Belt Company

COALS, STOKER, GAS SCREEN
Chesapeake & Ohio Lines
General Coal Co.
Pittsburgh Coal Co.

COAL WEIGHING AND MEASURING EQUIPMENT
Richardson Scale Co.

COCKS, AIR AND STEAM
Crane Co.
Dart Mfg. Company, E. M.
Fairbanks Company, The
Lunkenheimer Co., The
Nicholson & Co., W. H.
Williams Valve Co., The D. T.

COILS & BENDS, PIPE
Badger & Sons Co., E. B.

COMBUSTION CONTROL SYSTEMS
American Coal Burner Co.
Bailey Meter Company
Cash Company, A. W.
Engineer Co., The
Hagan Corporation
Hays Corporation, The
Republic Flow Meters Co.

COMBUSTION RECORDERS
Brown Instrument Co., The
Hays Corporation, The
Permutit Co., The

COMPOUNDS, PIPE JOINT
Smooth-On Mfg. Company

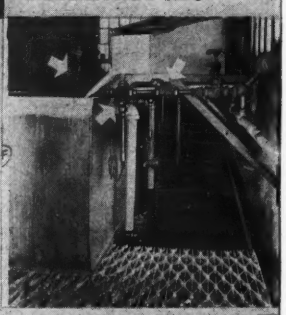
CONDENSERS
Allis-Chalmers Mfg. Co.
Condenser Service & Engrg. Co., Inc.
Elliott Company
Foster Wheeler Corporation
Worthington Pump & Machy. Corp.

CONDENSER TUBE SERVICE
Condenser Service & Engrg. Co., Inc.

CONTROL EQUIPMENT, ELECTRICAL
Cutler-Hammer, Inc.
General Electric Company

"WE SAVE STEAM AND CHEMICALS"

SAYS THIS NEW JERSEY MANUFACTURER



"Our plating department, formerly the bottle neck of most of our operations, is now our greatest asset.

"We had varying loads, varying tank temperatures and varying room temperatures, and these conditions, combined with our high standards of inspection, resulted in an excessive reject factor.

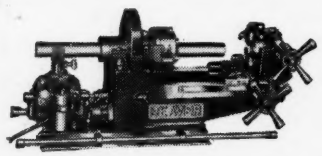
SARCO TEMPERATURE REGULATORS

"All tank temperatures are now held to within two degrees of the regulator settings, regardless of the volume of work or any other condition. With less evaporation, the solutions are held to uniform strength and we use less alkali. We use all condensate for rinse water."

SARCO SAVES STEAM

SARCO COMPANY, INC.
183 Madison Avenue, New York, N. Y.
SARCO CANADA LTD., FEDERAL BLDG., TORONTO, ONT.

IMMEDIATE DELIVERY!

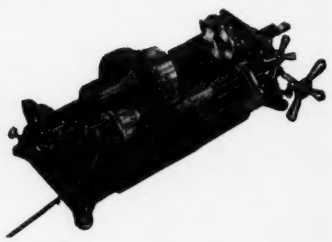


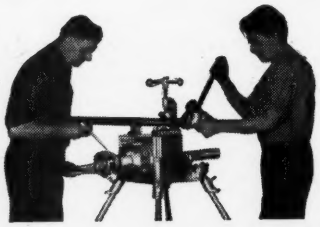
Beaver Model-A

A high-speed heavy-duty deluxe Pipe and Bolt Machine. Range ⅛ to 2-inch up to 12-inch with geared tools and drive shaft. Bolts ¼ to 2-inch. From $309.50 up. Wt. 415 lbs. Ask for Bulletin-A.

Beaver Model-B

A small utility Pipe and Bolt Machine combining many features of Model-A with the easy portability of Model-C. Range ⅛ to 2-inch up to 8-inch with drive shaft and geared tools. Bolts up to 1½-inch. Weight 280 lbs. From $217.50 up. Ask for Bulletin-B.





Beaver Model-C

A sturdy little Power Unit

Converts Hand Pipe Tools into Power Tools from ⅛ to 8-inches. Threads 8-inch in 6 minutes. Threads bolts up to 1½-inch. Equipped with automatic chuck wrench ejector—a safety feature. Two men can use it at the same time without interference. Easily portable—weighs about 150 lbs. From $125.00 up. Write for Bulletin-C.

BEAVER PIPE TOOLS

Highest Quality * WARREN, OHIO * For 40 Years

1240 POPLAR AVENUE